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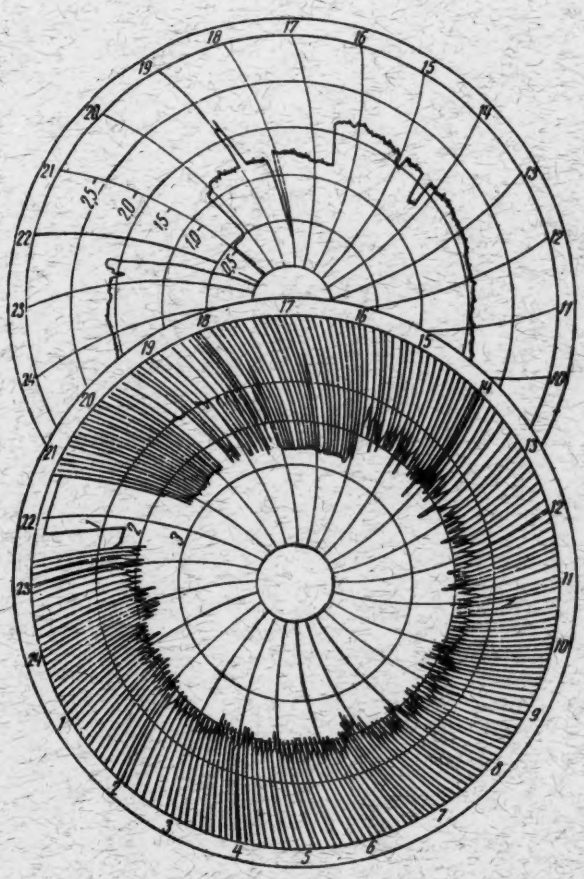
METALLURGIST

translated from Russian



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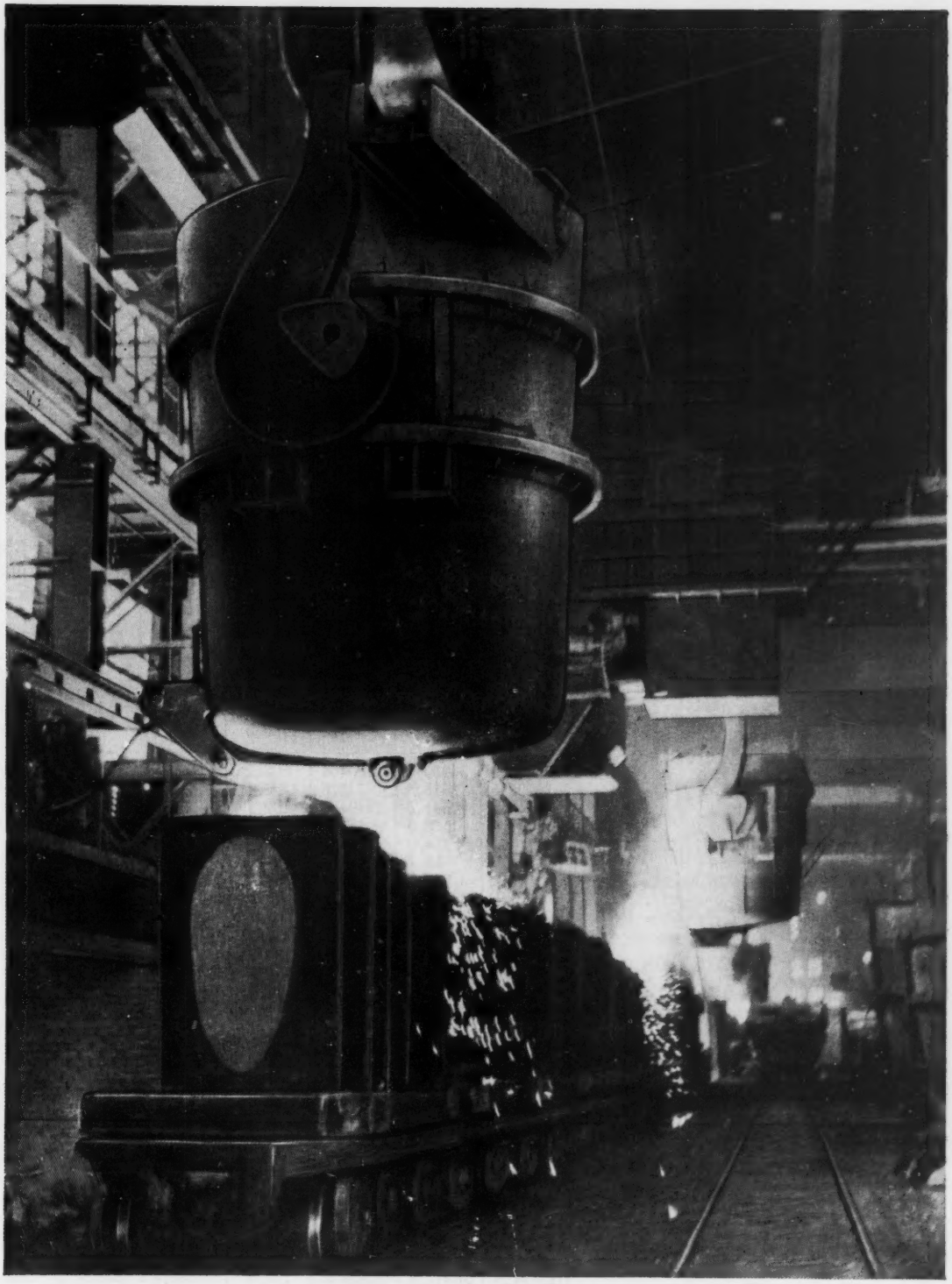

Casting of steel on the Martenovsk section of
"Zapozozhstal" works.

THE RISE OF THE SOVIET IRON AND STEEL INDUSTRY

Soviet iron and steel production – the basis of the socialist industry – is increasing rapidly.

The over-all production for the first 6 months of 1958 exceeded the planned target by 3.1%. Compared with the same period in the previous year, the output increased by 8.7%. Our metallurgists completed the production program ahead of schedule in all branches of the iron and steel industry. The large furnaces at the "Azovstal", Petrovskii, Krivoi Rog, and Enakievo Works and at the Orsk-Khalilovo Combine were put into operation ahead of schedule.

Table 1 gives details of the fulfillment of the production plan.

TABLE 1

Iron and Steel Production for 7 Months of 1958 (in thousand tons)

Product	Republic	7 months of 1957	7 months of 1958				7 months of 1958, compared with 7 months of 1957	
			planned	actual	% of planned	deviation from planned	+ –	%
Pig iron	Total in USSR	21315,4	22292,6	22530,1	101,1	+237,5	+1214,7	105,7
	RSFSR	10351,1	10542,7	10721,3	101,7	+178,6	+370,2	103,6
	Ukrainian SSR	10604,2	11367,0	11424,0	100,5	+57,0	+819,8	107,7
	Georgian SSR	360,1	382,9	384,8	100,5	+1,9	+24,7	106,8
Steel	Total in USSR	29354,8	30935,0	31604,3	102,2	+669,3	+2249,5	107,7
	RSFSR	16302,1	17318,8	17738,6	102,4	+419,8	+836,5	104,9
	Ukrainian SSR	11245,7	12241,6	12494,5	102,1	+252,9	+1248,8	111,1
	Georgian SSR	441,8	576,3	557,3	96,7	—19,0	+115,5	126,1
	Azerbaidzhan SSR	246,4	254,0	265,1	104,4	+11,1	+18,7	107,6
	White Russian SSR	43,9	55,1	54,4	98,7	—0,7	+10,5	123,9
	Uzbek SSR	131,9	133,5	139,9	104,8	+6,4	+8,0	106,1
	Kazakh SSR	146,1	156,5	155,6	99,4	—0,9	+9,5	106,5
	Latvian SSR	51,4	50,0	50,2	100,4	+0,2	—1,2	97,7
Rolled product	Total in USSR	22929,7	24131,6	24758,3	102,6	+626,7	+1828,6	108,0
	RSFSR	12928,7	13188,2	13534,9	102,6	+346,7	+606,2	104,7
	Ukrainian SSR	9223,2	10040,5	10320,3	102,8	+279,8	+1097,1	111,8
	Georgian SSR	423,6	406,4	382,6	94,1	—23,8	—41,0	90,3
	Azerbaidzhan SSR	19,1	158,9	177,3	111,6	+18,4	+158,2	в 9,2 times
	White Russian SSR	21,7	23,5	25,5	108,5	+2,0	+3,8	117,5
	Uzbek SSR	91,5	84,7	83,5	98,6	—1,2	—8,0	91,3
	Kazakh SSR	152,1	154,9	159,6	103,0	+4,7	+7,5	104,9
	Latvian SSR	67,2	71,3	72,1	101,1	+0,8	+4,9	107,3
Steel pipes	Total in USSR	2426,6	2576,6	2597,9	100,8	+21,3	+171,3	107,1
	RSFSR	1178,6	1275,1	1284,9	100,8	+9,8	+106,3	109,0
	Ukrainian SSR	998,6	1040,8	1041,7	100,1	+0,9	+43,1	104,3
	Georgian SSR	144,7	151,6	157,2	103,7	+5,6	+12,5	108,6
	Azerbaidzhan SSR	103,4	107,7	113,0	104,9	+5,3	+9,6	109,3
Iron ore	Total in USSR	48402,6	49887,3	50873,4	102,0	+986,1	+2470,8	105,1
	RSFSR	20471,9	20100,6	20463,5	101,8	+362,9	—8,4	99,95
	Ukrainian SSR	25194,5	26317,0	20803,4	101,8	+486,4	+1608,9	106,4
	Kazakh SSR	431,5	978,5	1023,0	104,5	+44,5	+591,5	237,0
	Azerbaidzhan SSR	661,5	696,2	692,5	99,5	—3,7	+31,0	104,7

TABLE 2

Performance Indices of Blast Furnaces in Various Republics and at Various Establishments

	Ratio of blast furnace useful volume to daily output (for nominal time of operation)		Idle periods of blast furnaces, % of nominal time of operation	
	1957	first half of 1958	1957	first half of 1958
Total for USSR	0.79	0.77	0.9	0.8
Republics:				
Russian SFSR	0.74	0.72	0.7	0.7
Ukrainian SSR	0.84	0.82	1.1	0.8
Georgian SSR	0.79	0.76	1.2	1.5
Establishments:				
Magnitogorsk Combine	0.63	0.61	0.7	0.5
Kuznetsk Combine	0.68	0.67	0.6	1.1
Serov Combine	0.64	0.64	0.2	0.2
Cherepovets Works	0.71	0.64	0.3	0.4

The total output of pig iron in the Soviet Union exceeded the planned target by 1.1%; 238,000 tons of pig iron over and above the planned target were produced. Compared with the same period of the previous year, the output of pig iron increased by 1,215,000 tons i.e. 5.7%. The efficiency of blast furnaces improved markedly (Table 2).

It is seen from Table 2 that blast-furnace operators at several plants achieved better performance indices of blast furnace operation than the average results for the whole Soviet Union; this fact indicates that potential reserves are still available which can be utilized to increase considerably the pig iron output at many works.

TABLE 3

Performance Indices of Open-Hearth Furnaces in Various Republics and at Various Establishments (for calendar time of operation)

	Steel output per 1 m^2 of furnace hearth per 24 hrs, * t		Idle periods of furnaces, % of calendar time of operation	
	1957	first half of 1958	1957	first half of 1958
Total for USSR	7.32	7.56	11.0	9.7
Republics:				
Russian SFSR	7.57	7.74	10.5	9.2
Ukrainian SSR	7.12	7.46	11.4	10.1
Georgian SSR	6.14	6.27	12.4	10.8
Azerbaidzhan	4.90	5.48	13.1	10.6
Establishments:				
Kuznetsk Combine	8.92	8.97	6.6	7.1
Magnitogorsk Combine	8.78	8.94	8.0	7.0
"Zaporozhstal" Works	8.88	9.03	10.2	8.5
Nizhne Tagil Combine	8.94	9.19	10.4	5.7
Petrovskii Works	7.83	8.16	10.0	8.8

* Data for the USSR and for the Republics are based on specialized works of relevant Sovnarkhozes.

TABLE 4

Productive Efficiency of Workers in Main Plants

	Output of pig iron, recalculated on conversion pig iron basis, per worker of the blast furnace plant, tons			Output of open-hearth steel per worker of the open-hearth plant at specialized works of the Sovnarkhozes, tons			Output of rolled product per worker of the steel rolling plant at the specialized works of the Sovnarkhozes, tons		
		1958			1958			1958	
	IVth quarter, 1957	Ist quarter	IInd quarter	IVth quarter, 1957	Ist quarter	IInd quarter	IVth quarter, 1957	Ist quarter	IInd quarter
Average for USSR	615	602	624	276	264	275	99	96	97
Russian SFSR	587	574	594	283	266	280	90	86	86
Ukrainian SSR	648	636	659	287	282	290	113	113	115
Georgian SSR	519	495	540	247	256	262	120	110	102
At individual works:									
Magnitogorsk Combine	1723	1724	1756	723	697	708	180	166	165
Kuznetsk Combine	1641	1675	1728	644	622	645	174	153	178
Nizhne-Tagil Combine	924	922	981	543	527	565	142	145	146
"Zaporozhstal" Works	1102	1039	1104	547	501	564	94	120	129

The best results with regard to the fulfillment of the plan were achieved by the works of the Sovnarkhozes (National Economic Councils) of the RSFSR; these works supplied the country with 179,000 tons of pig iron over and above the assigned target and increased the output by 370,000 tons compared with the corresponding seven months of 1957. It should be mentioned that apart from the Nizhne-Tagil Metallurgical Combine, all Sovnarkhozes and all industrial establishments of the RSFSR completed the plan for pig iron production.

Iron and steel works of the Ukrainian SSR produced, in the seven months of this year, 57,000 tons of pig iron over and above the planned target and so increased the output by 820,000 tons, or 7.7% compared with the corresponding period of the previous year. The pig iron production plan was completed by all Sovnarkhozes, but some works still do not make full use of existing potentialities and lag behind in plan fulfillment. To this category belong the Stalino, Il'ich, "Zaporozhstal" and Alachevsk Works.

The total output of steel in the Soviet Union for the seven months of 1958 exceeded the planned target by 2.2%. Our national economy received 669,000 tons of steel over and above the planned production. Compared with the corresponding period of the previous year, steel output increased by 2,250,000 tons or 7.7%. The main performance indices of open-hearth furnaces improved too (Table 3).

The best results with regard to the fulfillment of the production plan were achieved by the works of the RSFSR (planned target was exceeded by 2.4%), which produced 420,000 tons of steel over and above the planned target and increased the steel out put by 837,000 tons compared with the corresponding 7-month period of last year. Only two works in the RSFSR were seriously behind in the fulfillment of the plan: The Vyksa Works of the Gor'ki Sovnarkhoz which had a lower steel output than last year and the Kirov Works of the Leningrad Sovnarkhoz.

The iron and steel works of the Ukrainian SSR exceeded the production target by 2.1%, gave the country 253,000 tons of steel over and above the planned amount, and increased the output by 1,249,000 tons compared with the previous year. More than half (56%) of the total increase in steel output in the USSR comes from the works of the Ukrainian SSR. All works except the Krivoi-Rog Works completed the seven-month production plan.

Of the other Soviet Republics, the Georgian SSR remained substantially behind in the fulfillment of the production plan; the steel output was 19,000 tons (3.3%) short of the target. At the same time, steel output in the Georgian SSR increased by 116,000 tons (26.1%) compared with the previous year.

Open-hearth plants of some iron and steel works attained a much more efficient utilization of open-hearth furnaces (Table 3) and this fact also indicates that at many works there are still some untapped internal reserves for increased production.

In the output of rolled product in the USSR the planned target for seven months was exceeded by 627,000 tons (2.6%). The output increased by 1,829,000 tons (8%) compared with the corresponding period of last year.

The best results with regard to rolled steel production were achieved by the works of the Ukrainian SSR (2.8% above the target) which produced 280,000 tons of rolled steel over and above the planned target and increased the output by 1,097,000 tons (11.8%) as compared with the corresponding period of last year. All the works in the Ukrainian Republic except the Konstantinovka Works, improved their performance.

The metallurgical establishments of the RSFSR produced, in the 7 months of 1958, 347,000 tons of rolled steel over and above the target and increased production by 606,000 tons compared with the corresponding period of last year. All iron and steel works of RSFSR fulfilled their production plans with regard to rolled steel.

Rolled steel output in the Georgian SSR short of the planned target by 23,800 tons (5.9%) and fell by 41,000 tons (9.7%) compared with the corresponding 7 month period of last year.

The production plan with regard to the assortment of rolled steel products has been carried out less successfully.

Because some works did not carry out their assignments with regard to the assortment of rolled product provided for in the state plan, the effect of the over-all increase in production on the national economy is reduced and some consumers find themselves short of necessary steel product supplies.

While the over-all output of rolled steel product for the 7 months of this year was higher than provided for in the production plan, the output of rails, girders and channel beams, structural, tool, stainless and some other types of rolled steel products fell short of the planned target.

A tightening of the production discipline with regard to a strict adherence to the assigned program and the completion of placed orders is an urgent task and an essential condition for the economical effectiveness of the expansion in rolled steel production.

Regarding the operation of rolling mills, one has to mention such negative symptoms (the fight against which has to be intensified), as the production of material for which no orders were placed or the production of second-grade material in excess of the planned amount, whereby the planning of supplies to consumers is disrupted. For the six months of this year, 5,200 tons and 15,000 tons second-grade rolled material was produced in the RSFSR and 15,000 in the Ukrainian SSR respectively. In the same period, 19,700 tons and 10,800 tons of materials for which no orders were obtained, was produced in the RSFSR and the Ukrainian SSR respectively.

The seven month target with regard to the total steel pipe output in the USSR was exceeded by 21,000 tons, to which the RSFSR contributed 9,800 tons, the Ukrainian SSR – 1,000 tons, the Georgian SSR – 5,600 tons and the Azerbaidzhan SSR – 5,300 tons. Compared with last year, the production of steel pipe increased by 171,000 tons. All Republics of the Union achieved an increase in production.

In steel tube production, similarly to rolled steel product, the part of the production plan dealing with the expansion of assortment and supplies to consumers was carried out less successfully than the overall output.

The RSFSR and the Ukrainian SSR did not reach the planned target in the production of large-diameter welded pipes which are badly needed for national industries. The seven month plan of the delivery of gas pipes, large-diameter welded pipes, thin-walled seamless pipes, electric-welded, drawn and rolled pipes was not fulfilled.

The planned output of iron ore was exceeded by nearly one million tons and, compared with 1957, an increase of 2,471,000 tons was achieved.

Our metallurgists had considerable successes in improving productive efficiency (Table 4).

In the second quarter of 1958, the iron and steel works of the RSFSR increased productive efficiency, as compared with the first quarter, by 3.5% in the blast furnace plants and by 5.3% in the open-hearth plants, and the works of the Ukrainian SSR increased productive efficiency by 3.6% and 2.8% for the blast-furnace and

open-hearth plants respectively.

Analyzing the statistics of productive efficiency in the iron and steel industry (Table 4), we must keep in mind that the successes were achieved during the period when the change to the shorter working day took place resulting in some increase in the number of workers employed at continuously operating plants. With the eight hour working day, the 24 hrs. operation of the plant could be ensured by three teams (with relief staff to allow for days off) but on the change-over to a shorter working day it became necessary to arrange work in four teams.

The establishments of the ferrous industry did a great deal for the utilization of available productivity reserves when the reorganization to four-team work took place. Nevertheless, the change-over to the shorter working day entailed some increase in personnel and this, of course, had an effect on productive efficiency.

In spite of isolated shortcomings, production results for 1958 show that the iron and steel industry of the Soviet Union works efficiently and is successfully fulfilling the assignments of the state plan.

In contrast to the considerable achievements of the Soviet iron and steel industry, a marked production decrease of the iron and steel industry took place in big capitalist countries during the current year. For instance, the pig iron output for the first half of 1958 in the USA decreased by 39% compared with the corresponding period of 1957, and steel output decreased by more than 37%; in England, pig iron output and steel output in the same period decreased by 3.4% and 4.9% respectively; and in Germany the output of pig iron in the first half of 1958 fell by 2.4%.

The decisive factor in the successes of the Soviet metallurgists was the reorganization of industrial management carried out on the initiative of the Central Committee of the Communist Party of the Soviet Union in the summer of last year.

The steps, taken by the Party and the Government, aimed at an improvement in the economical and the technical management of the establishments and projects of the iron and steel industry, the regulation of remuneration and the shortening of the working day inspired creative efforts in metallurgists and miners and provided conditions for a successful carrying out of the tasks envisaged in the state plan.

The decentralization and the transfer of the managerial control to the places of production, the enhancement of the role and responsibilities of local management were conducive to revealing many potentialities and achieving a more efficient utilization of existing capacities. The successes of the iron and steel industry bear testimony to the possibility of making an even better use of the advantages of the socialist economic system, which advantages were revealed by the reorganization of industrial management.

S. M. Filipov

GOSPLAN (State Planning Commission) of the USSR.

THE BLAST FURNACE INDUSTRY

PRODUCTION OF HIGH-GRADE CONVERSION PIG IRON WITH MINERAL FUEL

P. S. Soloshenko

Director of the Almaznaia Metallurgical Works

The machine-building industry has special requirements with regard to the quality of special steels produced by the iron and steel industry.

The basic open-hearth furnaces ensure the production of quality steels, but the process requires pig iron of low sulfur and phosphorus contents.

Until 1939, low-sulfur and low-phosphorus pig iron was made with charcoal and, hence, the cost of this pig iron was very high.

In 1939, the Almaznaia Metallurgical Works began to introduce the production of high-quality pig iron with mineral fuel. For this purpose, the Works was supplied with Mushketova coke (containing about 1% sulfur), class 10 iron ore (containing up to 0.012% phosphorus) and grade I manganese ore.

It is known that a high basicity of the slag (not less than 1.4) is required for the production of low-sulfur pig iron (of less than 0.025% sulfur content) and, in order that its mobility be improved, the slag should contain up to 6% magnesium oxide.

At that time, the cost of high-quality conversion pig iron made with mineral fuel was lower than charcoal pig iron, but was still considerably higher than the cost of ordinary conversion pig iron. The reason was the low output of the blast furnace.

In 1949, the technology of treating pig iron with special reagents outside the blast furnace was developed, and thus it was possible to improve its quality and increase the output of the blast furnace.

In 1957, some improvements in technology and equipment were carried out: constant-humidity blast was introduced, the air-heating stoves were modernized (the cross section of the chambers was reduced), labor-consuming operations at the charge yard were mechanized, the pouring machine was put into operation, etc. As a result, the quality of the metal produced was improved, the mean 24 hr output of the blast furnace was increased by 5.1%, the temperature of the blast was increased from 500 deg C in 1955 to 670 deg C in 1957 and coke consumption in the same period was reduced from 968 kg to 867 kg per ton of pig iron.

As the consequence of the above measures, the coefficient of the utilization of blast-furnace useful volume (the ratio of blast-furnace useful volume to daily output) is 0.720 and the cost of high-quality conversion pig iron has decreased markedly.

One of the very important steps in the improvement of the efficiency and economy of the blast furnace process at the Works was the mastering of the production of low-manganese pig iron from Krivoi-Rog ores.

Tests on the production of low-manganese pig iron at the works in the South showed that the presence of about 6% MgO in the slag assures a satisfactory and constant mobility of the slag, in spite of its increased basicity.

Magnesium slags require a high heating temperature, at which they exhibit a better desufurizing power. These slags ensure a regular operation of the blast furnace at a higher blast temperature, cause a more extensive

TABLE 1

Mean Chemical Composition of Initial Materials for Smelting

Materials	Content, %												Lumpiness
	moisture	SiO_2	Al_2O_3	CaO	S	P	Fe	FeO	MgO	Mn	MnO	ash	
Iron ore													
class 10	4,74	9,80	1,04	0,57	0,007	0,015	61,8	—	0,99	—	0,061	—	2,0
class 33 . . .	3,39	17,62	0,90	0,86	0,014	0,019	55,94	—	1,08	—	0,076	—	77,1
Green slag from the Voroshilov Works. . .	—	31,6	12,40	30,60	3,0	0,005	—	1,27	—	—	12,5	—	—
Limestone:													
low-phosphorus .	—	1,12	0,24	54,43	—	0,003	0,13	—	0,74	—	0,077	—	—
dolomitized	—	1,08	0,15	30,01	—	0,003	0,26	—	14,5	—	0,077	—	—
Coke from the Zhdanov Coke and By-Product Works	2,52	—	—	—	1,8	—	—	—	—	—	—	9,52	—

TABLE 2

Operating Statistics of the Blast Furnace Before and During the Experimental Period

Operating conditions	Production of	
	high-quality pig iron	low-manganese pig iron
Number of charges	88	94
Blast rate, cu m/min	850-900	900
Blast pressure, atmos	0.70-0.80	0.75
Blast Humidity, g/cu m	20-25	20-25
Blast temperature, deg C	760-800	760-800
Slag basicity, $CaO : SiO_2$	1.33	1.33
Output of pig iron per charge, kg	4620	4600
Low running of the furnace, min	25	-
Idling of the furnace, min	30	-
Number of forced settlings	13	6
Consumption per 1 ton of pig iron, kg coke	855	830
Iron ore	1345	1409
Metallic additions	351	305
Manganese additions	165	57
Flux	572	608
Slag	0.654	0.625
Dust carry-out, %	21	19

manganese reduction, and prevent the reduction reaction of silicon and sulfur and their transfer into pig iron.

High-quality conversion pig iron of higher classes (A, B and C) are obtained from D-class high-quality pig iron by means of treating it with special reagents outside the blast furnace.

Usually, tapped liquid pig iron containing 0.30 - 0.50% Si, 1.30 - 1.50% Mn, 0.038 - 0.040 P and 0.050 - 0.060% S is subjected to the treatment.

The smaller the amount of the above elements in the initial metal, the more efficient are the dephosphorizing and the desulphurizing reactions and the smaller is the consumption of reagents per ton of pig iron treated. Thus, if the pig iron from the blast furnace contains 1.3% manganese, the content after the treatment is only 0.6%; the saving per ton of pig iron amounts to 10 kg of manganese. If, however, in the production of low-manganese pig iron, the initial material contains 0.40 - 0.50% manganese, the content after treatment with

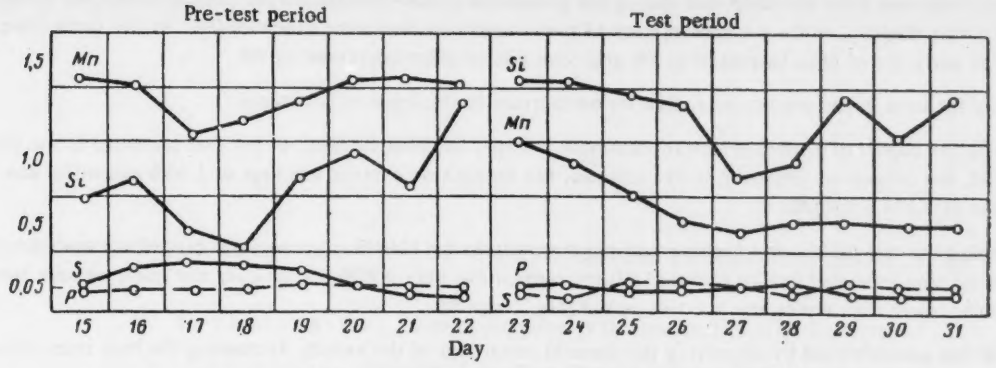

Fig. 1. Chemical analysis of pig iron as tapped

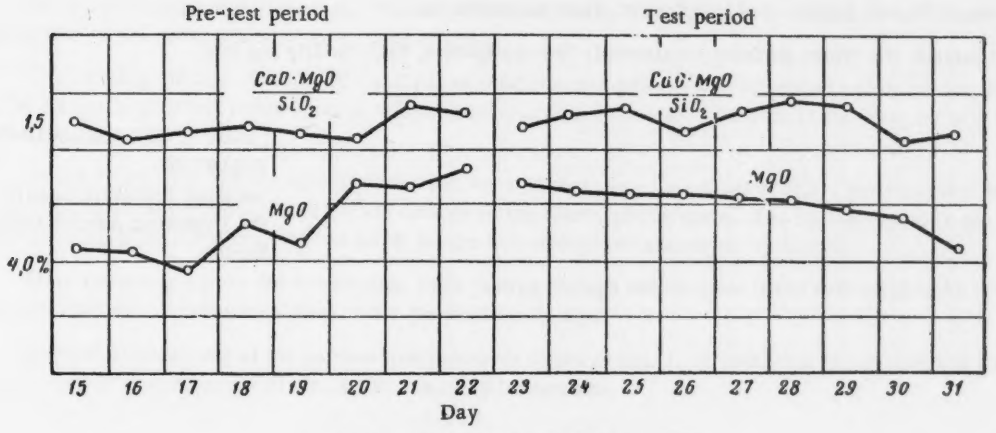

Fig. 2. Slag basicity and MgO content

reagents is 0.20 - 0.30% (the saving amounts to 3 kg of manganese).

Total savings, resulting from the reduced consumption of manganese and other materials, constitute about 600,000 rubles per annum.

In March 1957, tests were carried out at the Almaznaia Metallurgical Works on the production of high-quality, low-manganese conversion pig iron.

The average chemical composition of the initial materials is given in Table 1.

The use, in the ore charge, of up to 50% of class 33 lump ore and coke of over 25 mm fractions in the test smeltings ensured a regular operation of the furnace.

For the purpose of evaluating the economy of the production of low-manganese pig iron, let us compare the preceding period of production (from March 15 to 22), when high-quality conversion pig iron was produced, with the test period (March 23 to 31) when low-manganese pig iron was produced. In both periods, almost identical initial materials were used, only the amount of class 10 iron ore in the charge was somewhat larger in the period from March 15 to 20.

Operating statistics of the blast furnace during the pre-test and test periods are given in Table 2.

The output of the blast furnace during the production of low-manganese pig iron increased by 3.6% under the same blast and temperature conditions, the number of charges per 24 hrs being increased from 88 to 94. There were no stoppages or low running of the furnaces during the test period. The number of forced settlings decreased from 13 to 6 and the furnace operation was much more steady.

It is also seen from the table that during the production of low-manganese pig iron its output per charge decreased only slightly, while the consumption of metal additions decreased substantially. At the same time, ore burden per 1 ton of coke increased by 8% and coke consumption decreased by 3%.

The increase in the ore burden called for an increase in the input of limestone.

With the object of a more effective treatment, outside the blast furnace, of pig iron produced in the pre-test period, the content of silicon in it was reduced, the manganese content was kept at 1.53% and sulfur and phosphorus at 0.036 - 0.044%.

During the test period, the treatment of pig iron outside the blast furnace was not carried out and, therefore, the pig iron produced had an elevated silicon content and only 0.62% manganese; the sulfur content was substantially lower than during the pre-test period (Fig. 1 and 2).

All this was achieved by improving the thermal conditions of the hearth, decreasing the heat requirements for manganese reduction, lowering the amount of slag and improving its physical properties.

The tests carried out showed that the change to continuous production of low-manganese pig iron is possible if coke of 25 mm fraction and lump ore or sinter are available.

At present, the Works produces continuously low-manganese, high-quality pig iron.

"INDUSTRIAL AND ECONOMIC BULLETIN"
National Economic Council of the Luganskoe Administrative Region.

CONTINUOUS CONTROL OF THE COMPOSITION OF BLAST-FURNACE GASES

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N. N. Temnokhud, Engineer of the Blast Furnace Plant at the "Azovstal" Works

For a correct representation of the thermal conditions in the blast furnace, one needs to have continuous information on the composition of blast-furnace gases.

The existing method of automatic analysis of blast-furnace gases is still imperfect. Only carbon dioxide can be determined by this method and a complete picture of the thermal conditions in the blast furnace cannot be obtained.

At the "Azovstal" Works, experimental tests were carried out with optical-acoustic gas analyzers which determine the carbon monoxide and carbon dioxide in the blast-furnace gases. The optical-acoustic gas analyzers were developed and built by the GSKB for the manufacture of analytical equipment.

Blast-furnace gas from the dustcatcher, after passing through coarse filter filled with small coke (15 mm - 25 mm fraction), is taken by a hose to the gas-analysis section.

General arrangement of the gas-analysis section is shown in Fig. 1. It comprises the control and filtration section, three analyzers and electronic recording instruments.

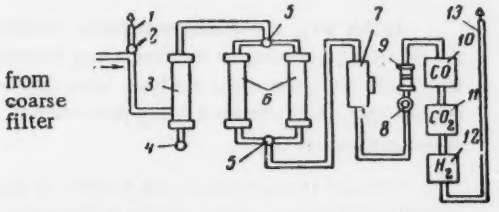


Fig. 1. General arrangement of gas-analysis section: 1) gas outlet to atmosphere; 2) control valve; 3) preliminary filter; 4) tap for condensate discharge; 5) three-way valve; 6) drying filter; 7) pressure regulator; 8) control filter; 9) rotameter; 10) CO analyzer; 11) CO_2 analyzer; 12) H_2 analyzer; 13) outlet to atmosphere

The section for control and filtration consists of a preliminary filter, two drying filters, a membrane-type pressure regulator, a control filter, and a rotameter. The preliminary filter contains bog iron ore which removes sulfur and arsenic compounds from the blast-furnace gas.

The drying filters are filled with granular calcium chloride and they remove moisture from the gas. A constant pressure of the gas mixture to be analyzed is maintained by means of a membrane-type pressure regulator.

The purified blast-furnace gas under a pressure of 20 - 40 mm of water passes, in turn, through the chambers of the optical-acoustic gas analyzers, the gas chamber of branch unit section and the hydrogen analyzer, and goes out to the atmosphere.

The principle of the carbon monoxide and carbon dioxide analyzers is based on the ability of these gases to absorb infrared radiation proportionally to their concentration, and the vibration of the gas under the action of intermittent infrared radiation.

The basic layout of the optical-acoustic gas analyzer is shown in Fig. 2.

The source of infrared radiation is two nichrome radiators with a current supply through a barretter from

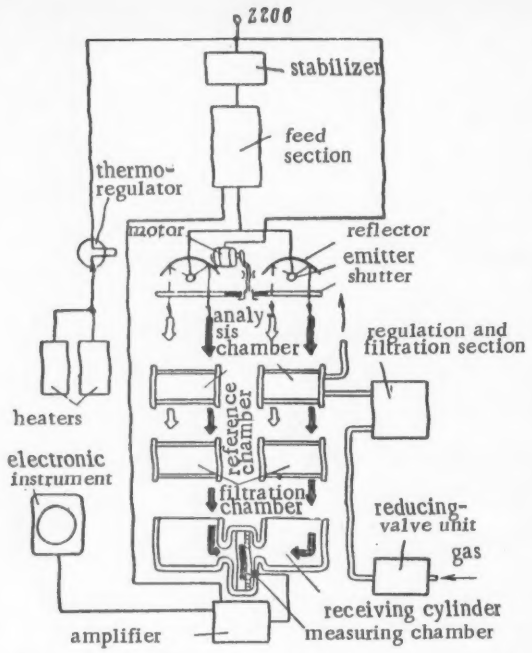


Fig. 2. Basic layout of optical-acoustic gas analyzer

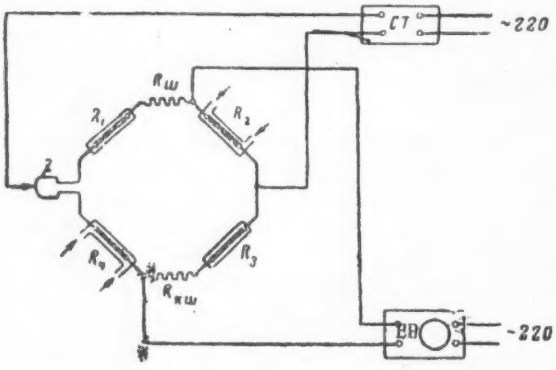


Fig. 3. Diagram of hydrogen gas analyzer:
R_1 and R_3 - reference resistances; R_2 and R_4 - measuring resistances; CT - voltage stabilizer; r - regulating resistance; EP - electronic potentiometer

a separate step-down transformer.

After being reflected from spherical metallic mirrors, diverse radiation beams enter two optical channels. The radiation is interrupted by means of a shutter six times a second in both channels simultaneously.

The right-hand channel contains analyzing chamber through which the gas mixture flows continuously. A reference chamber, filled with pure air, *is placed in the left channel symmetrically* to the analyzing chamber.

On passing through the analyzing chamber, the beam loses a portion of energy corresponding to the absorption line of the gas under analysis (black arrows). No absorption takes place in the left-hand channel. That part of the energy which corresponds to the absorption lines of the gas components which are not analyzed is absorbed in the filter chambers of the two channels (white arrows).

Only gas components which are not analyzed are in the filter chamber, so that a part of energy (black arrows) passes through them without marked losses.

The filter chambers of the carbon monoxide analyzer are filled with carbon dioxide and the filter chambers of the carbon dioxide analyzer are filled with carbon monoxide. The measuring chambers of the gas analyzers contain pure carbon monoxide and dioxide, respectively.

In this way, the radiation streams, entering the receiving cylinders of the measuring chamber filled with the gases under analysis, have different energies, the difference being proportional to the gas concentration.

Periodic fluctuations in the pressure in the receiving cylinders cause a change in the capacitance of the capacitor microphone included in the amplifier network. Current to the amplifier is supplied from a rectifier through an electronic stabilizer.

An EPD-17 electronic recording instrument is attached to the amplifier of the gas analyzer. In view of the high sensitivity of the external medium to temperature changes, the temperature of the receivers of the gas analyzer is thermostatically controlled.

The hydrogen analyzer is based on the principle of comparing thermal conductivities of the analyzed and reference gas mixtures. The comparison is made on the resistance of two resistors heated by electric current and surrounded with the gas mixture (Fig. 3). The temperature and the resistance of the resistor at a constant electric current depend only on the thermal conductivity of the surrounding medium.

Accuracy Tests of Gas Analyzers

Period	Error, %		
	CO_2	CO	H_2
April, 1955	+1,8; −2,35	+1,15; −2,56	+2; −2
February, 1957	+1,2; −2,2	+1,15; −2,5	+3,8; −3,6

The operation of the optical-acoustic gas analyzer for carbon monoxide, carbon dioxide and hydrogen at a blast-furnace plant was very successful. The readings of the instruments when they are in full working order do not exceed permissible error (± 5%).

The reading scale of the analyzer should correspond to the concentration range of the blast-furnace gas components: 7 - 15% CO_2; 25 - 35% CO; and 0 - 5% H_2.

The gas analyzers are tested 2 to 4 times a week by means of standard gas mixtures.

The results of gas analyzer tests for the period from April, 1955, to February, 1957, (see Table) show that the accuracy of the analyzer has not changed in spite of long service.

In the course of operation, the advantages of the optical-acoustic gas analyzers became apparent: they give quick analysis results (delays amount to 5 - 7 min); are reliable and accurate in operation; not more than 20 or 25 minutes per 24 hrs are needed for the operation of the instrument (apart from the calibration). If one instrument breaks down, the others are not affected.

The analyzers, however, have some disadvantages too. The lithium-fluorine windows cemented with BF-4 cement into the optical chambers frequently break down because the cement contracts on solidification, causing the appearance of some extra stresses. Because of the lack of a signalling system, a breakdown of the thermostat cannot be detected in time. Consequently, the temperature in the receivers of the analyzers changes rapidly and the readings of the instruments are distorted.

There is no equipment at the Works for the preparation of reference gas mixture for filling the measuring and filter chambers. This hinders the speedy elimination of any faults.

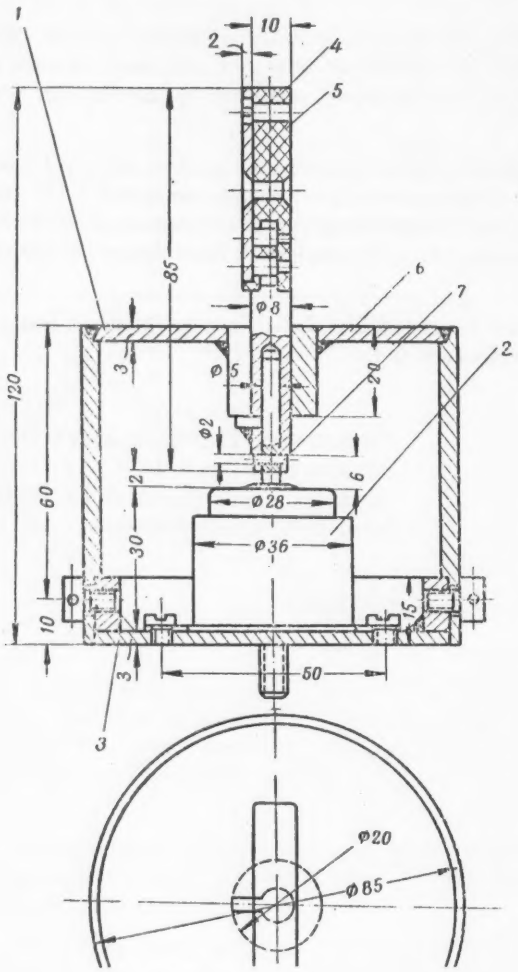
"BULLETIN OF TECHNICAL AND ECONOMIC INFORMATION" No. 6, 1958
National Economic Council of the Stalino Economic Administrative Region.

IMPROVEMENT IN SWITCH-LOCKING ARRANGEMENTS FOR LOAD-LIFTING EQUIPMENT

In the IVth quarter of 1956, all electric bridge cranes at our Works were equipped with switch-locking tallies whose arrangement is shown in the diagram.

The packaged breaker (2) is placed in the frame (1) and is fixed to the bottom plate (3) of the frame with two screws. The bottom plate is also attached to the frame with two screws, fastened on the outside.

The turning bar (7) is inserted into the stem of the breaker. When the key is inserted into the keyhole, the turning bar enters a slot in the lower end of the key stem. The turning of the key switches the breaker on. The disc of the key (4) of the switch-locking tally is made of an insulating material in order to protect the crane operator from an electric shock when the switch tally is inserted. The tally (5) is also insulated and is attached to the key by means of two screws sunk through the bottom from the inside. The tally is mounted on the safety panel of the secondary commutation of the crane.



Each electric bridge crane or some other load-lifting mechanism has its own switch-locking tally on which the characteristics and registration number of the lifting equipment are given. The key of the switch tally fits to one mechanism only.

With such an arrangement, a given machine cannot operate without the tally, since the current for the load-lifting equipment is switched on by means of the key of the switch tally. During the operation of the equipment, the key remains in the lock. In order to prevent the key from falling out of the lock, there is on the stem a bit (6) which on being turned leaves the slot in the tube of the frame and inserts itself behind the inner end of this tube.

After completing the work, the operator turns the key of the tally through 1/4 circle in the opposite direction and thus switches off the current to the crane.

The switch tally can be used on all electric bridge and jib cranes (tower and cantilever cranes), on charging machines at the open-hearth plants, on scale cars, turning hoists, casting machines, etc.

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TREATMENT OF ALLOY STEEL UNDER VACUUM

G. A. Sokolov, G. N. Oiks and I. I. Ansheles

Moscow Steel Institute

In November, 1957, the equipment for liquid steel treatment under vacuum was put into operation at the electric steelmaking plant of the "Krasnyi Oktiabr'" Works.*

For the vacuum treatment of steel in the ladle, the operating vacuum (15-20 mm Hg) in the chamber is established in 2-3 min; and during the evacuation of several heats the final pressure falls to 4.5-7 mm Hg or even below that value. Fig. 1 shows the time taken for the establishment of vacuum for some of the heats.

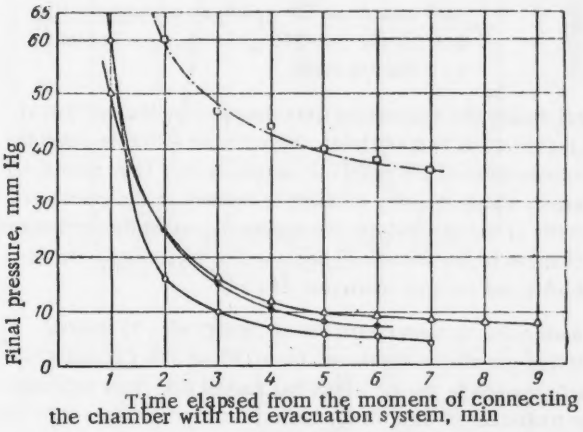


Fig. 1. Speed of vacuum establishment in the vacuum treatment of steel in the ladle (data from various heats).

In the course of the operation of the equipment, the effects of vacuum treatment in the ladle and of pouring the steel under vacuum on the quality of steel 30KhGSA, made in electric arc furnaces, were studied.

Vacuum Treatment in the Ladle

In order to ascertain the effect of the vacuum treatment, the method of steelmaking was continued unchanged during the first period of the investigations. The steel (12 ton heat) to be vacuum treated was tapped into a 20 ton steel-pouring ladle which had adequate reserve volume necessary for the boiling of the steel.

After the steel had been transferred into the ladle, it was placed in the vacuum chamber, the lid was closed and the chamber was connected to the vacuum system. During the whole time of evacuation, the surface of the slag in the ladle and the condition of the nozzle were watched.

It was found that during the vacuum treatment the behavior of steel from various heats was approximately the same. After the final pressure of 40-50 mm Hg has been reached, cracks begin to appear in the skin of the slag and from these cracks flame tongues which increase gradually, begin to emerge. The slag skin becomes distorted and breaks; at a pressure of 15-25 mm Hg the steel and the slag begin to boil. In almost every heat, a short (1-1.5 min) period of vigorous boiling was observed; during this period the boiling was accompanied by a rise of steel and slag by 300-400 mm and some slag was sometimes splashed out of the ladle. The commencement of the period of the vigorous boiling is marked by a copious evolution of smoke which impedes observations. Later on the intensity of boiling somewhat subsides, and the next period takes various courses: for some heats the steel continued to boil vigorously at the walls of the ladle and near the stopper while at the center of the ladle

*The description of the equipment was given in the "Metallurgist" No. 3, 1958.

TABLE 1

Composition of the Gases Evolving During the Vacuum Treatment of Steel in the Ladle

Steel grade	Heat number	Final pressure, mm Hg	Amount %		Gas consumption, %*				
			Air	Gas	CO	CO_2	N_2	H_2	CH_4
30KLGSA	3364	50	67,8	32,2	19,7	17,2	34,2	28,6	0,3
		36	70,8	29,2	13,7	14,1	51,2	20,7	0,3
		36	68,7	31,3	12,3	13,3	55,0	19,4	—
	2299	14	69,0	31,0	19,7	6,1	18,2	56,0	—
	3665	22	45,1	54,9	8,5	4,3	66,9	20,3	—
		20	45,3	54,7	7,5	4,8	64,2	23,5	—
ShKh15	3589	16	72,1	27,9	21,6	7,6	31,4	39,4	—
	3309	40	50,4	49,6	17,3	3,0	13,3	66,4	—
		35	54,2	45,8	14,3	5,7	18,8	61,2	—

*Gas analysis was carried out with VTI apparatus

the boiling gradually subsided and the slag skin appeared again; for other heats, after the end of the vigorous boiling period, an intense boiling continued over the whole surface of the steel in the ladle, often until the end of the evacuation.

After a vacuum of 15-20 mm Hg pressure had been attained, the evacuation operation was usually continued for not more than 5-7 min. because of the danger of damaging the chamotte-clay nozzle and partly because of inadequately high temperature of the steel at the time of tapping. The measurements of temperature by means of an immersion thermocouple indicated that the mean temperature drop during the time of placing the ladle in the vacuum chamber, removing the ladle and during the evacuation, constituted 30-50 deg. C.

In order to investigate the change in the gas content in steel resulting from the vacuum treatment, the samples taken from the ladle before and after the vacuum treatment were analyzed by the method of vacuum melting. The analysis showed that in the course of vacuum treatment the hydrogen content falls by 0.3-2.0 cu. cm/100 g, the nitrogen content by 0.0007-0.003%.

No regular changes in the oxygen content in steel during the evacuation were detected by the analysis of the samples. Theoretical calculations indicate that in the electrically made steel subjected to diffusion deoxidation and to the additional deoxidation with Al, the concentration of the dissolved oxygen is very low, almost all oxygen being present in the form of nonmetallic inclusions which are very difficult to remove in the course of the evacuation process. This was confirmed by the results of the electrolytic determination, carried on at the same time, of nonmetallic inclusions in steel. No regular changes in the amount of nonmetallic inclusions were detected in the samples taken from the ladle before and after the vacuum treatment of steel.

The analysis of the gases*, however, evolving during the vacuum treatment of steel (Table 1) showed that, side by side with hydrogen and nitrogen, the evolving gas always contained from 12% to 37% CO and CO_2 (CO_2 is the product of the secondary reaction of CO with oxygen in the air which has leaked in). This indicates that reduction reactions take place during the vacuum treatment of steel in the ladle.

We have to assume that during the vacuum treatment of steel in the ladle two opposite processes take place: one is the process of the contamination of steel with the constituents of the refractory materials of the ladle, the refractories of the ladle being extensively eroded during the boiling of the steel and slag, and the other is the process of the decomposition (reduction) of oxide inclusions by carbon dissolved in the steel. The change in the content of oxygen and nonmetallic inclusions in the upper layers of the steel is, apparently, the result of these two simultaneous processes. At the same time, these processes are obscured by the process of the floating-up of inclusions under the gravitational forces and with the bubbles of the dispersed gas phase which evolves under the vacuum.

It should be mentioned that steel samples for the determination of nonmetallic inclusions and oxygen were taken from the upper layers of the steel in the ladle immediately before and after the evacuation. At present, nonmetallic impurities are determined in the finished steel with the object of finding a possibility of a further purification of steel from these inclusions.

* Gas analysis was carried out by the personnel of the Thermotechnical Laboratory of the "Krasnyi Oktiabr'" Works

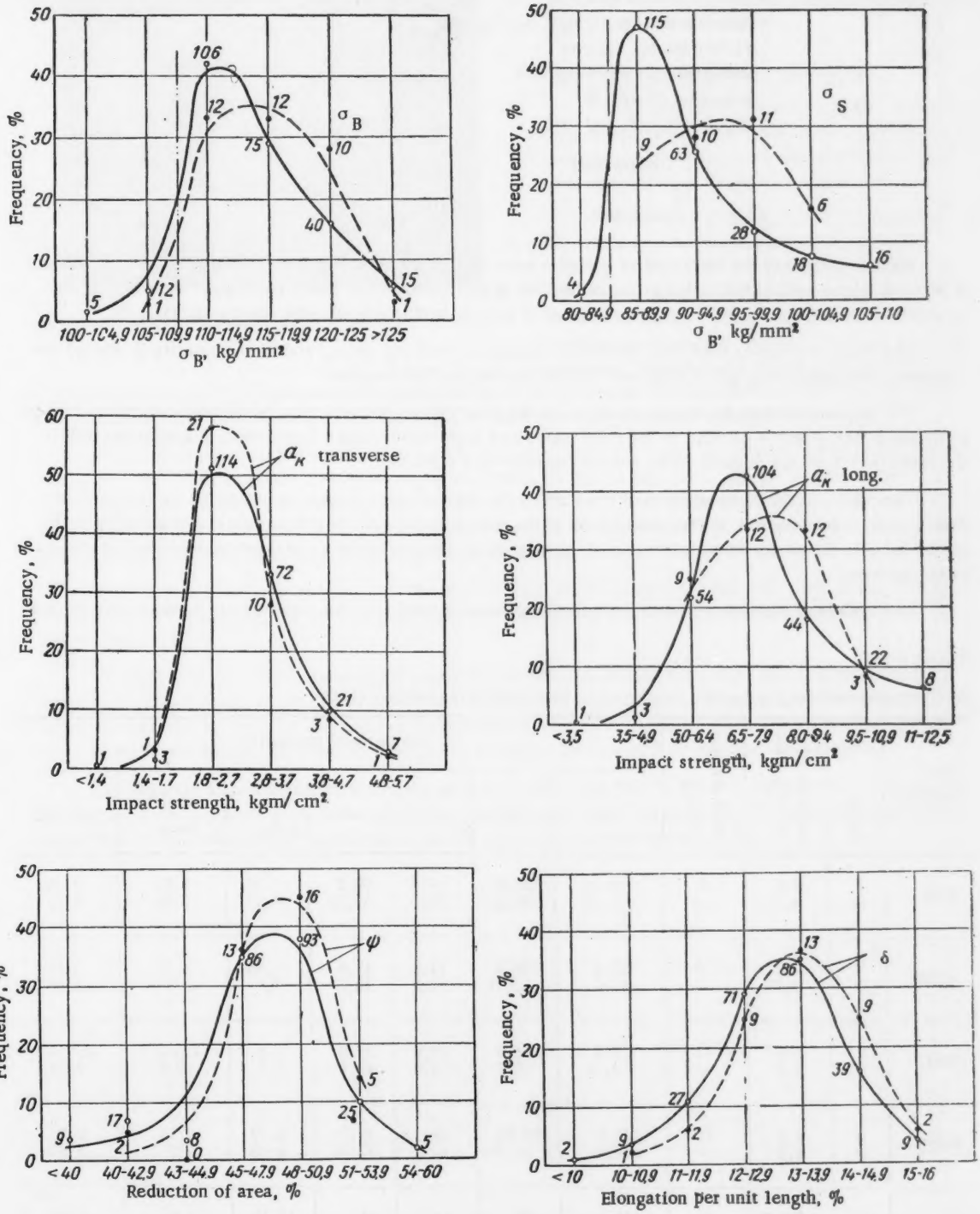


Fig. 2. Frequency curves of mechanical properties of steel (the continuous line represents the experimental heats; the dotted line represents the ordinary heats)

Results of vacuum treatment. 30KhGSA steel, made at the plant, is subjected to mechanical tests specified in the TU 2333-49. The mechanical properties of the steel should be as follows:

Ultimate tensile strength, σ_b, kg/mm^2	110
Yield point σ_s, kg/mm^2	85
Elongation per unit length, %	10
Reduction of area, %	45
Impact strength, kg/cm^2:	
a_k longitudinal	5
a_k transverse	1.8

For comparison of the steel quality, samples were taken from 14 experimental heats and from 88 ordinary production heats, melted and rolled at the same time as the experimental heats, and frequency curves of the mechanical properties of steel* for the experimental and the ordinary heats were constructed (Fig. 2).

The frequency curves show that the tensile strength of steel (σ_b and σ_s) and steel plasticity (δ and ψ) are increased; the impact strength is improved only in the longitudinal samples.

The improvement in the tensile strength and the plasticity of the steel may be explained by the reduction of hydrogen and nitrogen contents in the steel, since at a high vacuum and a fairly small height of the steel in the ladle (~ 1.2 m) the degasification process becomes very effective.

The results of the macroanalysis of the steel of the experimental heats were compared with those of ordinary steel. On the whole, the macrostructure of the experimental and the ordinary steel was found to be the same; the only difference noted was a slightly smaller axial and total porosity of the steel subjected to the vacuum treatment.

The surface of the rolled product from the experimental steel was somewhat better: product rejected due

TABLE 2

A Comparison of the Mechanical Properties of Evacuated and Ordinary Steels

Heat number	Index	Duration of pouring, min	Final pressure, mm Hg	Mechanical properties						
				σ_b	σ_s	δ	ψ	a_k' long.	a_k'' trans.	$a_k' : a_k''$
2378	V	2,5	6	118,75	99,75	14,5	50,5	7,10	3,25	2,18
	O	4,0	—	116,50	93,25	14,0	49,75	7,17	3,32	2,16
V0509	V	2,5	7,5	125,5	106,5	12,5	47,0	6,65	2,75	2,42
	O	3,75	—	116,0	93,75	15,0	49,7	7,5	2,6	2,88
T0817	V	2,5	11	114,0	89.0	14,0	51,0	7,8	4,0/2,7	2,2/2,8
	O	4,0	—	112,25	90,5	14,5	47,4	6,5	2,6	2,50
T0828	V	3,0	10	118,5	100,75	13	45,0	6,12	2,75	2,22
	O	4,0	—	106,5	84,75	13	43,75	9,75	2,7	3,6
T0984	V	2,5	14	111,2	86	14	51	11,15	3,9	2,86
	O	4,0	—	113,75	89	12	40,5	9,4	4,2	2,24

* Two samples were tested for each property; when the test was repeated, two samples were again used.

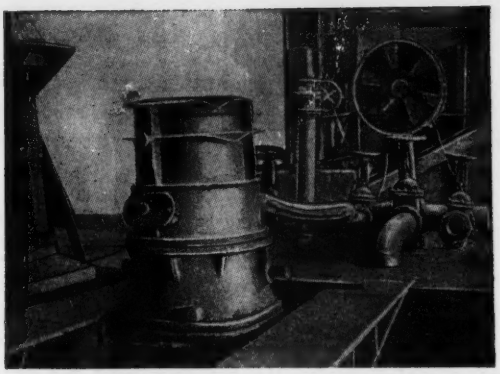


Fig. 3. Equipment for pouring the steel under vacuum

to surface defects at the blooming mill amounted to 0.81% for the experimental steel compared with 1.69% for the ordinary steel.

Pouring Steel Under Vacuum

In the course of the investigation, the pouring of steel under vacuum by a new method—without vacuum chambers—was mastered; the vacuum was established directly inside the mold.

Fixed-bottom molds for 4.1 ton ingot, of the same type as the molds used for bottom-pouring at the plant, are used for the pouring of steel under vacuum. The hot top, which has a machined flange on its upper end, is fitted tightly onto the machined edge of the mold. A rubber washer is placed on the flange of the hot top and the intermediate vessel is fitted onto the rubber washer; in its lower part the intermediate vessel has an outlet for gas evacuation. The vessel is connected to the vacuum system by means of a flexible hose (Fig. 3).

The intermediate pouring vessel is lined with chamotte brick; the vessel can accommodate 350 kg of liquid steel. The steel is poured through a magnesite nozzle, 30 mm in diameter. For the purpose of establishing a preliminary vacuum, the nozzle is covered with a steel plate, 1 mm thick, and is sealed with a coating of graphite powder mixed with liquid glass. In order to reduce the splashing of the steel stream, a ceramic extension piece of 80 mm diameter is fixed underneath the pouring nozzle.

20-30 min before the steel is poured, the intermediate vessel is heated to 400-600° C by means of a gas burner. Before the pouring, the vacuum pumps are switched on and the mold is evacuated down to 10-12 mm Hg pressure.

The filling of the intermediate vessel begins at the full rate of steel flow, the ladle stopper being fully opened. The steel plate, which covers the nozzle, melts in 1.5-2 secs; in that time, a layer of liquid steel which prevents the air from rushing into the mold accumulates in the intermediate vessel. From then on, the level of the liquid steel in the ladle is regulated by adjusting the rate of flow with the ladle stopper.

Immediately after the pouring starts, the pressure in the mold falls to 5-7 mm Hg since any leaks at the sealing plate are eliminated; the vacuum remains constant until the mold is filled. The pressure is increased when the hot top is filled — the upper half of the hot top is filled at atmospheric pressure.

The time for filling the body of a 4.1 ton ingot through a 40 mm diameter nozzle is 2.5-3.0 mins; this is 1.5 times less than for bottom pouring.

It was found by visual observations that the stream of steel leaving the ceramic extension piece had no regular outlines, and a vigorous splashing was frequently observed. The surface of the rising steel in the mold remained clear and had a characteristic metallic lustre; small-bubble boiling of the steel, more intense near the walls of the mold, was noticeable.

In view of the fact that the steel was poured into the molds which were not coated, the boiling may be regarded as the result of the evolution of gases from the steel, the evolution being especially vigorous at the boundary of the liquid steel and the mold.

The surface of the top-poured ingots under vacuum is not very different from the surface of ordinary, bottom-poured ingots. Unlike the ordinary ingots, the vacuum-poured ingots have no folds. Sometimes, the edges of the vacuum poured ingots are covered with a porous layer of shallow scale. It is probable that a part of splashed steel falling on the walls of the mold during pouring has no time to melt in the rising metal and is subsequently oxidized when the gap between the mold and the ingot is formed. The inspection of hot ingots revealed this scale layer to be 0.5-1.0 mm thick and, apparently, completely oxidized when the ingots are heated in the soaking pits, since no surface defect of that kind was found on the billets.

The mechanical properties of rolled steel, both vacuum poured and ordinary, were compared in samples taken from each heat. It should be pointed out that in all cases the ingot poured under vacuum was the last one in each heat, that is to say that it was most extensively contaminated with nonmetallic impurities.

Mean readings of two tests for each mechanical property are given in Table 2.

An analysis of the results given in Table 2 shows that in most cases the mechanical properties of steel poured under vacuum are better than those of steel bottom-poured under atmospheric pressure.

The macrostructure of top-poured ingots under vacuum was not substantially different from the macrostructure of ordinary ingots. In all cases, the macrostructure of the experimental steel was sound and conformed to the requirements of TU. The development of segregation was observed to be somewhat less extensive in the vacuum poured ingots.

On the whole, top poured steel under vacuum is superior to ordinary steel from the same heat with respect to mechanical properties and is not inferior with respect to the macrostructure and surface quality of rolled steel.

Further work on the improvement and development of this simple method of steel pouring under vacuum is essential in order to make use of well-known advantages of top-pouring with regard to the yield of acceptable product and to the savings in auxiliary materials and equipment.

CONTINUOUS CASTING OF SQUARE INGOT FROM STEEL

V. S. Rutes and N. A. Nikolaev

TsNIIChM

(Central Scientific Research Institute of Ferrous Metallurgy)

In 1953, a commercial-scale, experimental machine for continuous casting of steel – one of the largest units of this type in the world – was built at the Novo-Tula Metallurgical Works. The machine was designed by the Stal'proekt on the basis of research carried out earlier at the TsNIIChM.

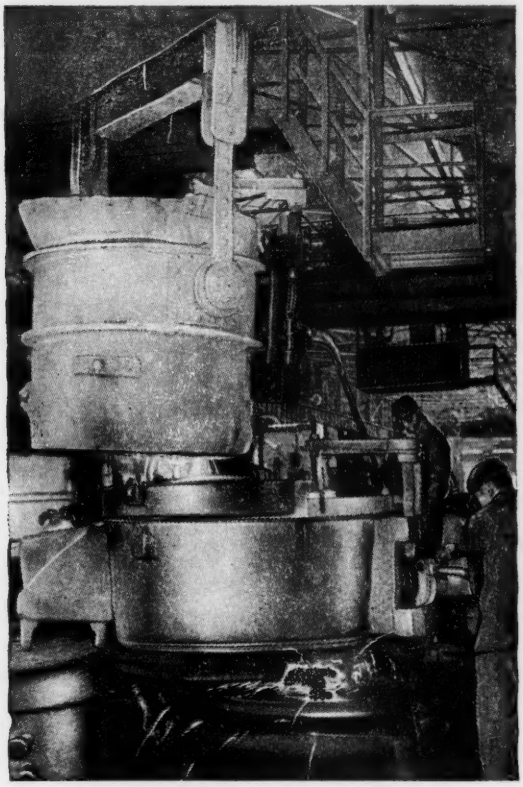


Fig. 1. Casting platform of the continuous casting machine at the Novo-Tula Metallurgical Works

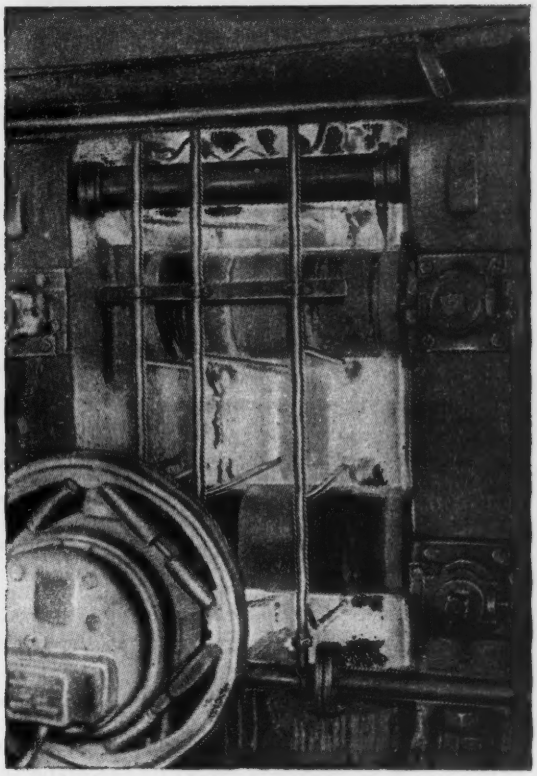


Fig. 2. The ingot passes through the upper pulling stand

Up to 1957, the technique of casting 150 x 500 mm slabs with this machine (the slabs being subsequently rolled into steel plate) was studied. About 17,500 tons of slabs were cast during three years.

In December, 1956, the casting of 200 x 200 mm square ingots was begun. It is well known that the output of a continuous casting machine, when the ingots of a given cross section are cast, depends on the speed of pouring, which is limited by a number of factors, in particular by the distance between the level of the steel in the crystallizer and the place of cutting the continuous ingot into uniform length, or in other words, by the height of the machine. If the permissible speed of casting is exceeded, the quality of the ingots is impaired and a breakthrough of liquid steel from within the ingot may occur.

A considerably higher output can be achieved when wide rectangular slabs are cast than in the case of rectangular billets with the side equal to the thickness of the corresponding slab. Thus, the output of the machine constituted 30-35 tons/hr. when 150 x 500 mm slabs were cast, but only about 15 tons/hr. when 150 x 150 mm billets were cast.

In order to increase the output during continuous casting, the steel from one pouring ladle can be taken to several crystallizers. This method was applied for the continuous casting of 200 x 200 mm square billets at the Novo-Tula Works.

The pouring ladle with the liquid steel is delivered to the pouring platform. The steel from the bottom nozzle of the ladle enters a special intermediate ladle and is distributed into two crystallizers (Fig. 1). When a definite level of the steel in the crystallizer has been reached, the mechanism for moving the ingots is switched on and its speed is accelerated up to the desired value. At the same time special pieces which serve as the bottom of the crystallizers at the commencement of pouring move downwards together with the solidifying ingots. The zone of secondary cooling is below the crystallizers where the surface of the ingots is cooled with water, finely dispersed by means of special sprayers. The solidification of the metal is thus speeded up and an excessive temperature of the surface due to the heat stored in the inside of the ingot is prevented.

The ingot is driven by two stands of driving rolls situated, respectively, at a depth of 3 m and 8 m below the floor level of the plant (Fig. 2 and 3).

Below the second driving stand, at a depth of 8-14 m beneath the plant floor level, the ingot is cut into uniform lengths by means of acetylene-oxygen torches, mounted on a special trolley moving on the guiding columns. By means of pneumatic fastenings, the torch is clamped to the ingot and moves downward together with the ingot while cutting it; at the same time, a special tilting crib is placed under the ingot.

Under the weight of the cut-off ingots, the crib descends to the roller table, situated at a depth of 19 m below the floor level, turns into the horizontal position (Fig. 4) and places the ingots onto the roller table which transfers them to the hoist which takes the ingots to the upper roller table at the floor level. The ingots are then transported to storage where their surface is conditioned, inspected and they are cut into the required lengths.

The control of all operations is effected from the control desks situated at various levels of the machine and interlinked with the central control desk on the pouring platform.

The machine is equipped with controlling and measuring instruments which make not only the control but also any required study of the process possible.

In the course of 1957, semi-commercial production of 200 x 200 mm ingots was mastered; thousands of tons of steel were cast on the machine. During that time, many units of the machine were improved, the process of casting ingots of various steel grades (St. 3, St. 5, U7 – U13, SKhL1 – SKhL4) was studied and worked out, and the quality of the cast ingot and of the rolled product was investigated.

The normal course of the casting process and the quality of the ingots produced depend to a great extent on the smooth functioning of the pouring apparatus which serves for the distribution of the steel into separate streams, the retention of the slag and an accurate control of the metal stream entering the crystallizers. The pouring apparatus is a low, oval-shaped, refractory-lined vessel which, in its bottom part, is provided with a nozzle closed with stoppers (Fig. 5). Since the quantity of the steel passing through each nozzle of the pouring apparatus is relatively small, one should aim at reducing the diameter of the nozzle as far as possible (down to 25 mm) in order to obtain a continuous, well-shaped and non-splashing stream of flowing steel. In order to

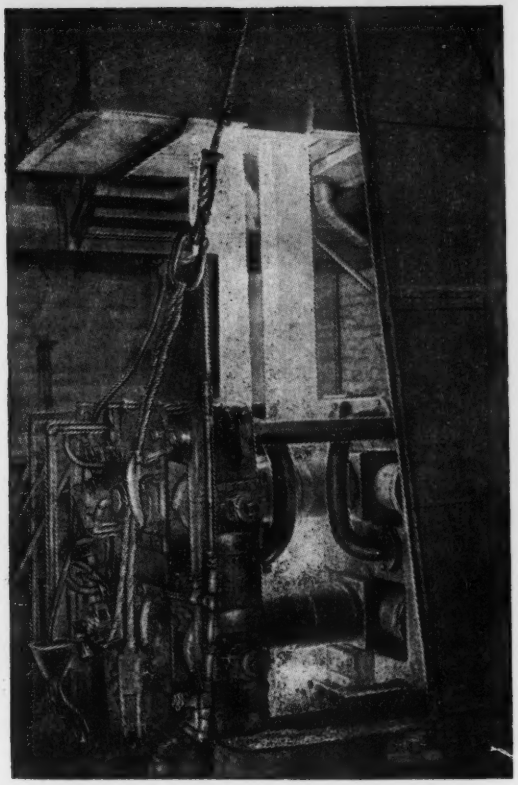


Fig. 3. Ingots passing through the lower driving stand

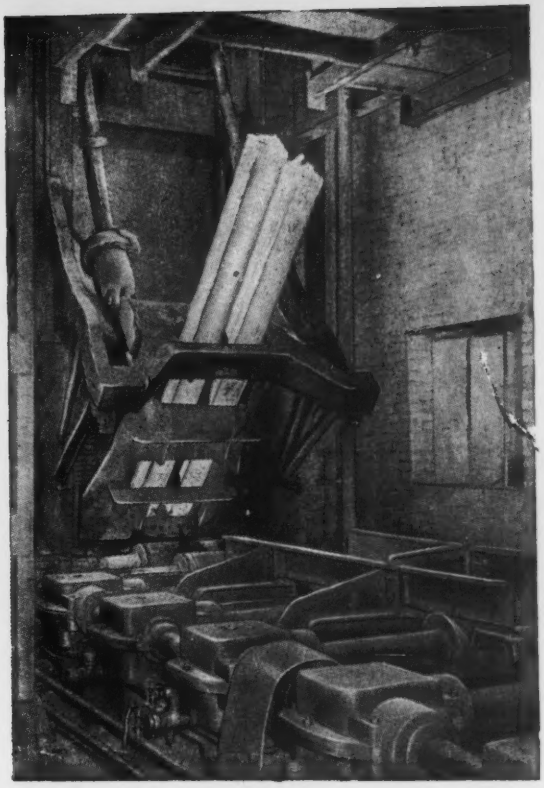


Fig. 4. Ingots being transferred to the lower roller table

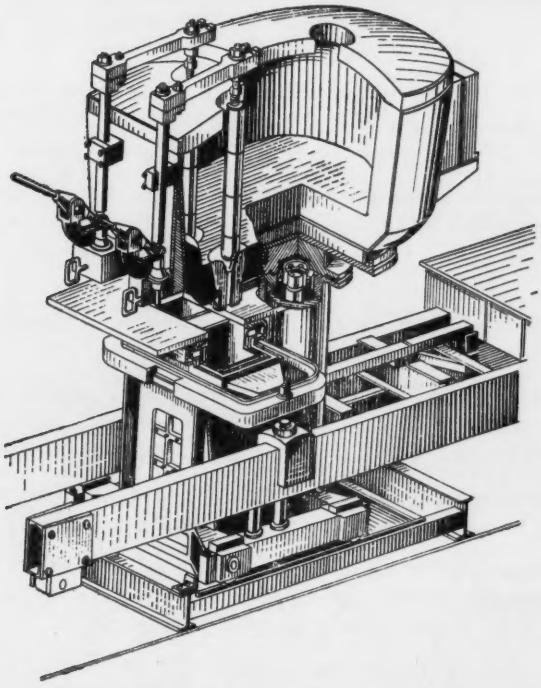


Fig. 5. Pouring apparatus

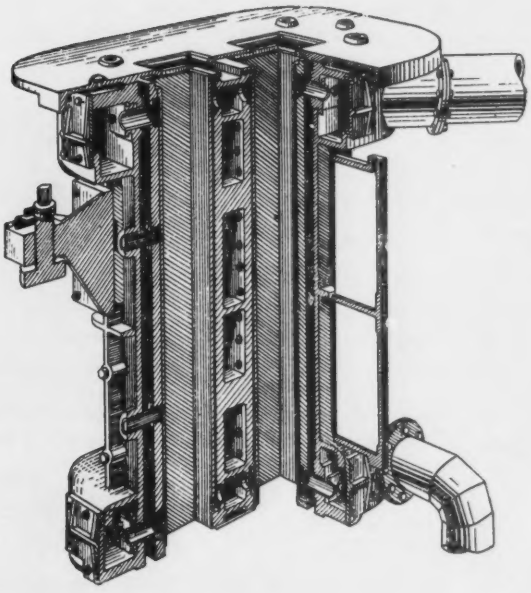


Fig. 6. Two-ingot crystallizer

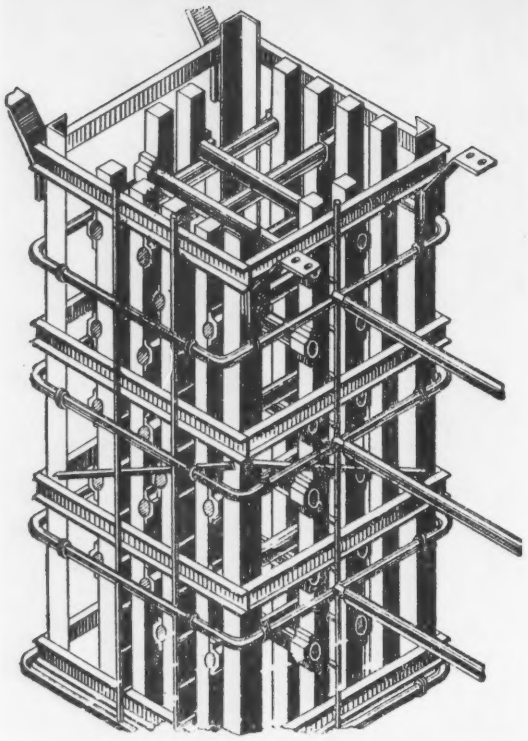


Fig. 7. System of secondary cooling

prevents the solidification of the steel in the nozzle, graphite chamotte nozzles, heated before and during the pouring by electric current from the welding transformer, are employed. For the same purpose, the pouring apparatus is covered with a lid and heated with gas burners to a temperature of 850-1000 deg C before the pouring. The pouring apparatus is mounted on a special turning table.

The two-stream crystallizer (Fig. 6) is 1.5 m long. The crystallizer of each stream consists of four separate walls, each wall being comprised of two rigidly joined plates: a copper plate which constitutes the internal enclosure of the crystallizer, and an external steel plate.

Water from a pump enters the bottom heater, circulates in the channels between the plates, and leaves through the top heater. All eight walls of the crystallizer are assembled in one common housing which is mounted on the bearings of the reciprocating-motion mechanism.

The oscillating movement of the crystallizer in a vertical plane (the amplitude of the oscillation is about 20 mm) facilitates the lubrication of the crystallizer in the zone which is cleared of metal and exposed when the crystallizer is lifted; the lubrication, while reducing the friction between the surface of the ingot being formed and the walls of the crystallizer, minimizes the possibility of transverse ruptures of the still thin skin of ingot when it is pulled out. In addition, when the crystallizer descends at a speed equal to the speed of the ingot, the ruptured skin is formed again.

Paraffin is used as the lubricant; it is fed in liquid form onto the surface of the copper walls from a special apparatus situated in the upper part of the crystallizer. The lubrication not only reduces the friction, thus making possible a higher rate of pouring, but also provides a protective atmosphere preventing the oxidation of the steel.

The system of secondary cooling (Fig. 7) consists of free-running rolls assembled in a frame. Between the rolls there are water sprayers which spray the surface of the ingots with finely dispersed water. The overall length of the secondary cooling zone is 7 m, the rolls; however, are provided over a length of 3 m; there are no rolls below the first driving stand.

The quality of the ingots produced in continuous casting depends mainly on the speed of pouring, the regime of the secondary cooling and the temperature of the liquid steel at the time of casting.

For an output satisfying the requirements of commercial production, the recommended speed of casting the medium-carbon steels, (St. 3 – St. 5) is within the limits of 0.7 m/min and 1.1 m/min. External longitudinal cracks appear on ingots cast at speeds exceeding 1.1 m/min, especially if steel is at a high temperature.

An increase in the speed of casting causes some deterioration in the quality of the internal zones of ingots, the axial sponginess, chemical nonuniformity and the tendency to internal crack formation being increased.

At a mean casting speed of 0.7 m/min, 30% of the samples taken from cast ingots of steel grade St. 3, had a slightly increased axial sponginess and 70% of the samples had no axial sponginess whatsoever. When the speed of casting was increased to 1.0 – 1.2 m/sec, 45% of the samples had a pronounced axial sponginess.

The increase in chemical nonuniformity and the tendency to internal cracks in the ingots cast at an increased speed are due to the following causes. The time necessary for a complete solidification of the ingot of

a given cross section is a fixed quantity; for instance, it is 9.5 min for the 200 x 200 mm ingot. Hence, we can calculate at what distance from the meniscus of the liquid steel in the crystallizer the ingot of a given cross section will completely solidify. Thus, at a casting speed of 0.7 m/min this distance or, as it is called, "the depth of liquid shaft", is 0.7 x 9.5 = 6.65 m, and at a speed of 1.0 m/min it is 1.0 x 9.5 = 9.5 m. Since the rolls of the first driving stand on the casting machine at the NTMZ are at a distance of about 5 m from the top of the crystallizer, the 200 x 200 mm ingot, even at a casting speed of 0.7 m/min, has liquid core when it enters the rolls. At a higher casting speed, the volume of liquid metal in the center of the ingot increases and the thickness of the solid film (skin) of the ingot decreases. At the same time, the strength of this skin decreases too and, consequently, the rolls of the first stand begin to compress the ingot. The higher the speed of casting, the lower becomes the strength of the skin and the greater becomes the compression. This causes tensile stresses in the weak, internal layers of the solid skin, the formation of internal cracks and so-called segregation bands perpendicular to the sides which were in contact with the rolls.

Thus, when the ingot is compressed, the higher the speed of casting, the greater is the probability of the appearance of internal cracks and chemical nonuniformity in the form of segregation bands. These facts, established clearly for the first time in the tests on casting square ingots with the continuous casting machine of the Novo-Tula Works, are of great practical importance in the further development of the process of continuous steel casting and for the design of equipment. The tests showed that in order to improve the quality of ingots cast on the continuous casting machine the design of the machine should be such as not to allow any compression of the ingots before their complete solidification.

The investigations also showed that an intensive cooling of ingots with water in the secondary cooling zone may cause internal cracks in the ingots. The recommended water consumption for secondary cooling is about 0.2 liters per 1 kg of steel.

Good results with regard to the surface quality, mechanical properties and internal structure of rolled steel were obtained in the course of rolling more than 6000 tons of 200 x 200 mm ingots of St. 3 steel grade cast on the machine of the Novo-Tula Works.

On the basis of experience in the continuous casting of rectangular and square ingots, large, many-stream machines have been designed for several works in the Soviet Union. At present, some of these machines are already in the course of construction.

MECHANIZATION OF LABOR-CONSUMING OPERATIONS AT THE MMK

V. P. Emel'ianov

The Magnitogorsk Metallurgical Combine

Extensive work has been carried out at the Magnitogorsk Metallurgical Combine on the mechanization of separate stages of the technological process, the working conditions being thus markedly improved and the productive efficiency increased.

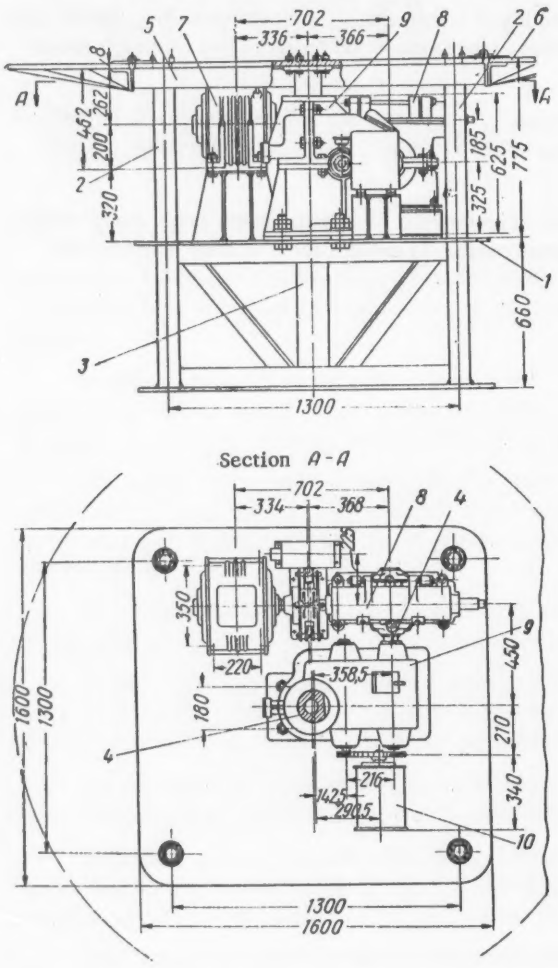


Fig. 1. Mechanized lifting table for lining the ladle.

In the present article, we give a description of some of the equipment designed for the mechanization of labor-consuming processes at the open-hearth furnaces of the Combine.

The mechanized lifting table for lining steel-pouring ladles. Previously, during the lining of pouring ladles, wooden trestles had to be introduced manually into the ladle and they had to be readjusted and extended every now and again inside the ladle. The bricklayers had to spend a considerable time on these operations. The lifting table, introduced on the proposal of I. N. Kutnii and I. S. Kovalik, eliminates unproductive time expenditure by the bricklayers.

In Fig. 1 the following designations are used: 1) bearing plate; 2) guide tubes; 3) column; 4) toothed rail; 5) top platform; 6) hinged flaps; 7) electric motor; 8) worm reduction gear; 9) rack and pinion gear box; 10) KA-4044 control apparatus.

The bearing plate of the lifting table (Fig. 1) supports four guide tubes and a column. Inside the tubes there are pillars; inside the column there is a movable rail. The pillars and the rail support the upper circular platform. With the object of reducing the size of the platform when it is not in its working position, hinged flaps are fixed on two opposite sides of the platform; they are raised when the table is to be placed in the ladle. The flaps are held in horizontal position by means of angles. The bearing plate accomodates an electric motor and the lifting mechanism, i.e., the worm reduction gear and the rack and pinion gear box. The electric motor is connected to the mains by means of a flexible cable (armored), covered with a thick

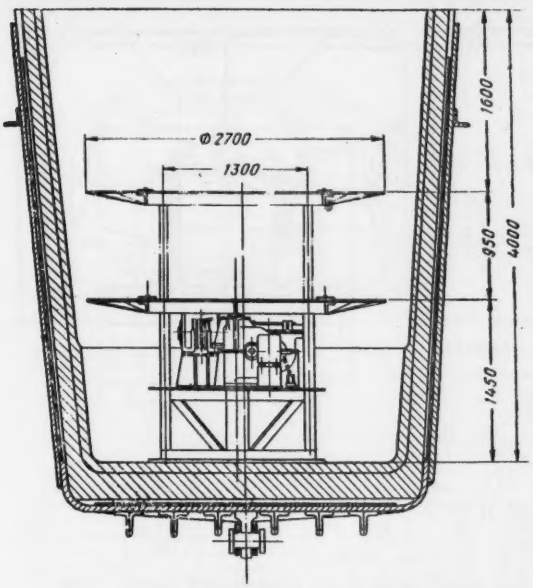


Fig. 2. Lifting table placed in the ladle.

rubber insulation. When the table is placed in the ladle, the cable terminus is inserted into the connection rose. The required height of the table is set up by means of the control apparatus connected with the rack and pinion box through a pair of toothed wheels. A chain and stirrup which can be hooked to the cantilever crane, serve for placing the table in the ladle (Fig. 2).

By means of the pouring or the cantilever crane, the table is placed in the ladle in which the bottom and part way up the walls have already been lined. The remainder of the ladle walls is lined by the bricklayer working on the table which is lifted when required. The lifting of the table is carried out by the helpers – brick carriers – by means of buttons set up on the cantilever crane situated nearby. The order for lifting the table is given by the bricklayer working in the ladle. After the ladle has been lined the table is removed by means of the crane.

The table is designed to carry three bricklayers and up to 0.5 tons of refractory bricks. The load-lifting capacity of the lifting mechanism is even greater.

The introduction of the lifting table resulted in an improvement in the operating efficiency of the bricklayers by 20-25%.

The mechanization of the preparation of materials for mixing in the clay mixer. For dressing the hot tops, a paste consisting of definite proportions of chamotte powder and clay mixed with water, is used at the

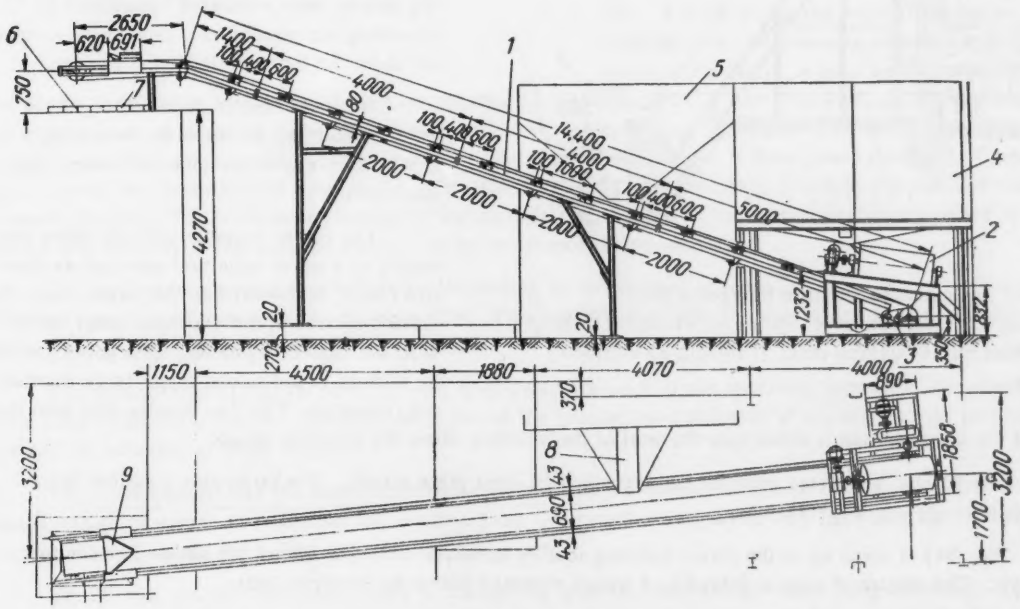


Fig. 3. Equipment for screening and transporting chamotte powder and clay:
1) belt conveyor; 2) rotary screen; 3) drive; 4) powder bin; 5) clay bin; 6, 7) feed bins; 8) trough; 9) plow.

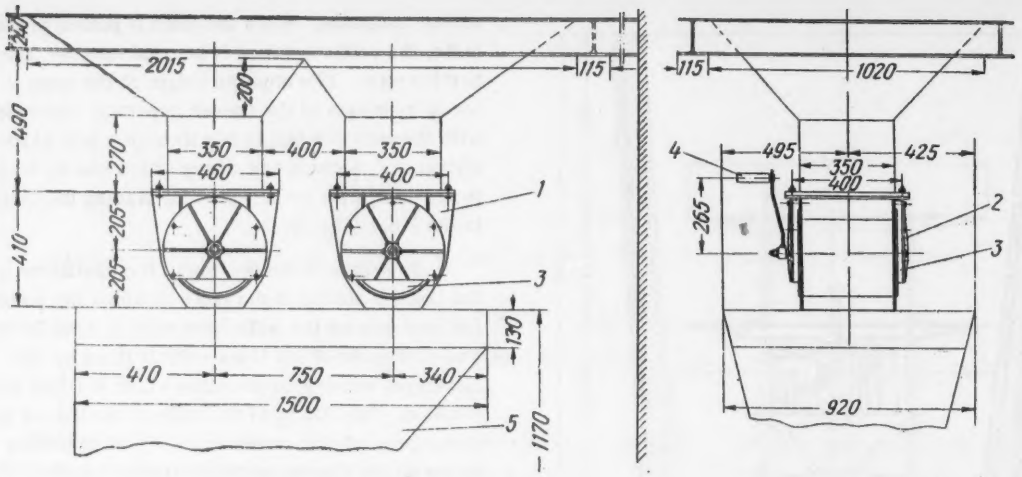


Fig. 4. Proportioning feeders:
1) cylindrical body; 2) end covers; 3) drum; 4) handle; 5) trough.

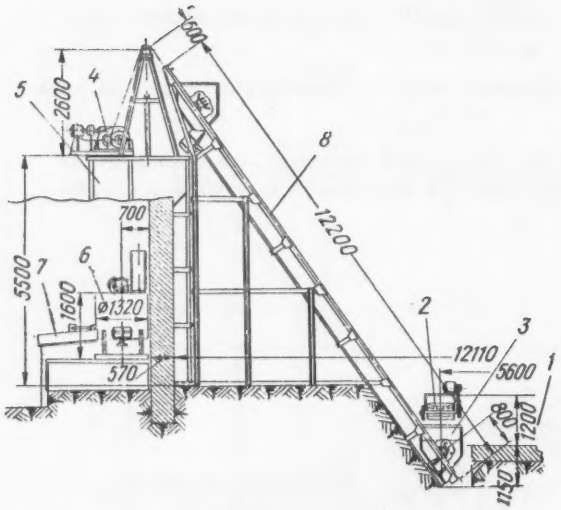


Fig. 5. Arrangement for lime transportation:
1) trench; 2) belt conveyor; 3) bin; 4) winch; 5) slaking tank feed bin; 6) slaking tank; 7) trough; 8) inclined bridge.

mold yards of the open-hearth plants. The paste is prepared in a special building (Fig. 3) where the mixer is installed. About 18 tons of the mixture (3 tons of clay and 15 tons of chamotte powder) is used in every 24 hrs for dressing the hot tops.

Previously, the components were proportioned, mixed and charged into the mixer by hand. The materials were finally mixed and humidified in the mixer. Large fractions of the powder were separated beforehand by screening the powder on a hand sieve, suspended under the bin containing the powder.

We succeeded in mechanizing these labor-consuming processes by combining a belt conveyor with the bins and rotary cylinder screen.

The screen together with the drive consisting of a worm reduction gear and an electric motor, is mounted on the frame above the driving section of the conveyor under the bin with the chamotte powder. The powder is fed by a chute to the screen where large fractions are separated. The fine powder falls onto the belt of the conveyor and is taken onto the roof of the building where the mixer is set up.

The powder is directed onto the conveyor belt by steel plate shields. The large-size fractions fall through a trough into a special box.

The clay is taken up to the mixer building roof by the same conveyor from a bin situated beside the conveyor. The stream of clay is guided by a trough mounted above the conveyor belt.

The material is fed into the mixer from above, in batches, through feed bins and proportioning vessels suspended under the feed bins. The upper end of the bins is mounted in the ceiling of the mixer building. The

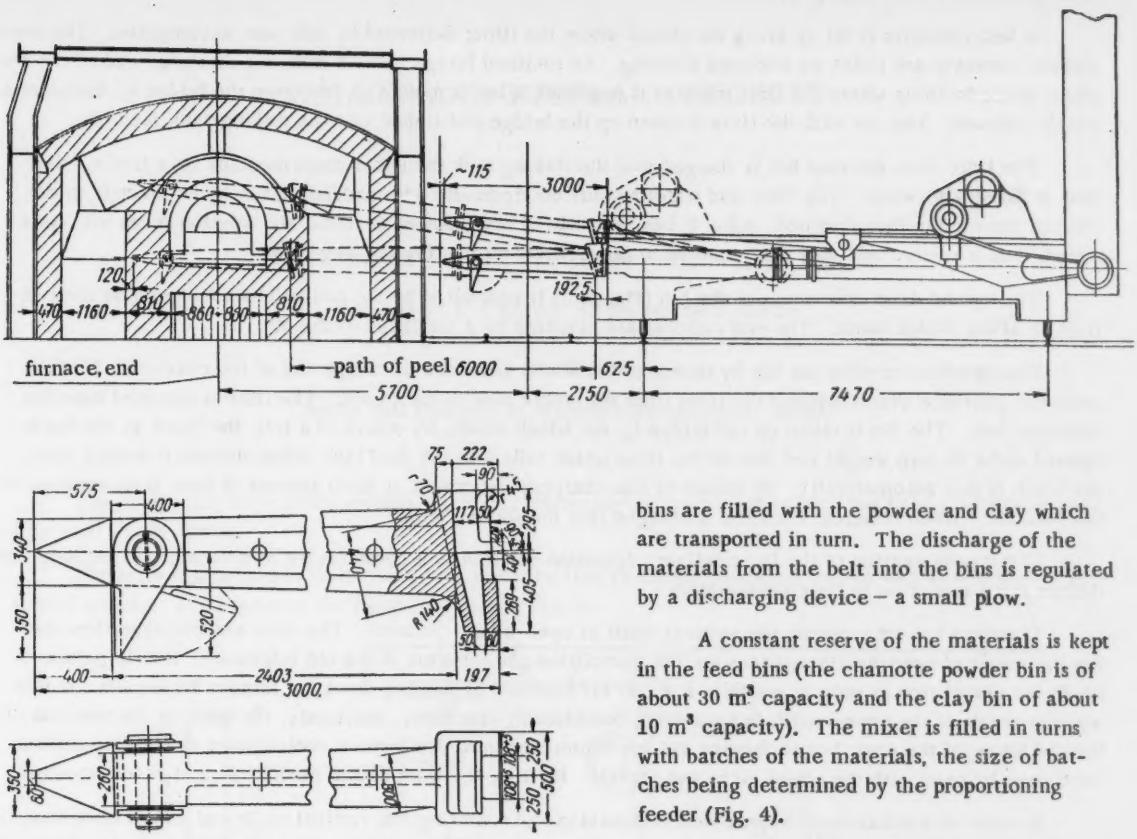


Fig. 6. Slice bar for breaking down the vertical walls of open-hearth furnaces

bins are filled with the powder and clay which are transported in turn. The discharge of the materials from the belt into the bins is regulated by a discharging device – a small plow.

A constant reserve of the materials is kept in the feed bins (the chamotte powder bin is of about 30 m^3 capacity and the clay bin of about 10 m^3 capacity). The mixer is filled in turns with batches of the materials, the size of batches being determined by the proportioning feeder (Fig. 4).

The proportioning feeder consists of the cylindrical body bolted to the funnel of the bin. A drum inside the body of the feeder is supported by two trunnions mounted in the side walls of the body. A hand lever is attached to one of the trunnions on the side of the working platform. The cylinder is a tube, blanked at both ends and having in its side a slot equal in size to the opening in the feed-bin funnel. By means of the handle, the slot is brought under the funnel, and the cylinder receives the feed. The cylinder is then turned through 180° and the feed falls on the trough and into the mixer. The feed bin funnel is at that time closed by the cylinder wall opposite the slot. The preliminary mixing of the materials is effected by the alternate charging of the chamotte powder and the clay in the required proportions by the proportioning feeder.

The equipment operates intermittently, depending on the amount of materials taken from the feed bins. The conveyor is used once or twice during a shift. Two workers cope with the operation of the equipment, including the preparation of the charge in the mixer.

The introduction of this set of equipment facilitated the work of the operating personnel and released three workers for other duties. The mechanization of the proportioned charging of the mixers may be recommended for adoption at other Works.

The mechanization of the preparation of lime solution. To extend the life of the slag pots, used for the transportation of slag in the steelmaking industry, their inner surface is sprayed with lime solution. A uniform coating of lime covers the surface after it has been dried.

Up till now, the delivery of the lime to the slaking tank has been a labor-consuming operation. The lime was carried on special handbarrows or in covered bins to the tank. When transported uncovered, the lime was blown by the wind, the loss of material being substantial. Now, a set of mechanical devices which ensure the transportation of lime without the use of manual labor and without loss of material, has been installed in the

lime preparation section (Fig. 5).

A belt conveyor is set up along the trench where the lime, delivered by rail cars, accumulates. The trench and the conveyor are inside an enclosed building. An inclined bridge extends from the discharge end of the conveyor to the building where the lime solution is prepared; a bin is moved up and down the bridge by means of a winch and rope. The bin with the lime is taken up the bridge and tipped into the slaking-tank feed bin.

The lime from the feed bin is charged into the slaking tank through a chute mounted on a frame. The tank is filled with water. The lime and water are stirred vigorously with paddles driven by an electric motor, milk of lime being thus obtained. After it has been stirred and allowed to settle, the solution is run off, via a trough, into a reserve tank and then pumped to the sprayers for coating the slag pots.

The up and down movement of the bin (Fig. 5, 3) is controlled by the end switches mounted on each extremity of the bridge beam. The end switches are actuated by a rod fitted to the bin.

The operator transfers the bin by means of the winch under the discharge end of the conveyor. He then starts the conveyor which delivers the lime from the whole area of the trench. The lime is shoveled onto the conveyor belt. The bin is taken up the bridge by the winch where, by means of a roll, the hatch in the bin is opened under its own weight and that of the lime which falls into the feed bin. When the bin is moved down, the hatch is shut automatically. By means of this charging equipment, a fixed amount of lime is maintained in the feed bin. When required, the lime is charged into the slaking tank.

The mechanization of the lime delivery operation resulted in a considerable improvement in working conditions and a reduction in lime consumption.

The slice bar for breaking the vertical walls of open-hearth furnaces. The most arduous operations during the repair of open-hearth furnaces are the demolition and removal of the old brickwork. It is important to begin the demolition as soon as possible, i. e., at the moment of shutting down the furnace for repairs. In this way the repair of the open-hearth furnace takes considerably less time. Previously, the work on the removal of the old lining of the open-hearth furnace did not commence until the furnace cooled down because operations were done by hand with the use of picks and shovels. Even so, the work had to be done in a high temperature.

In order to mechanize the operations on breaking and removing the vertical walls and end of open-hearth furnaces, on the proposal of I. S. Obsiannik, a special slice bar with a scraper which can be attached to the peel of the charging machine (Fig. 6) has been adopted at the Magnitogorsk Metallurgical Combine.

The slice bar is cast from steel and is provided with a lock, fitting the head of the peel of the charging machine. The bar has a sharp-pointed end so that it can easily cut into the brickwork. The scraper, by means of which the charging machine operator removes the bricks into boxes set in front of the furnace, is hinged on a shaft secured to the bar, near its end, by a washer and a cotter pin. In this way, the brickwork of the whole front wall of the furnace is pulled down and scraped out.

When the peel is turned through 180°, the scraper falls under its own weight onto the bar. The front wall is demolished with the slice bar in this position. For scraping the rubble out, the peel is turned into the initial position.

The use of the slice bar for the demolition of the front wall speeds up and considerably facilitates the repair of the open-hearth furnace. The bar is of a simple design and is convenient to operate. It can be recommended for use during repairs of open-hearth furnaces at other works.

EXPERIENCE IN ROLLING PERIODIC SECTIONS OF SMALL CROSS SECTIONAL AREA

G. K. Eremin

Senior Roll Designer at the Sulin Metallurgical Works

The production of periodic section No. 8 for reinforced-concrete constructions has been mastered at the wire mill of our Works.

The mill is arranged in three lines: the reducing line (2 stands), roughing line (3 stands) and finishing line (7 stands). The layout of the stands is shown in Fig. 1.

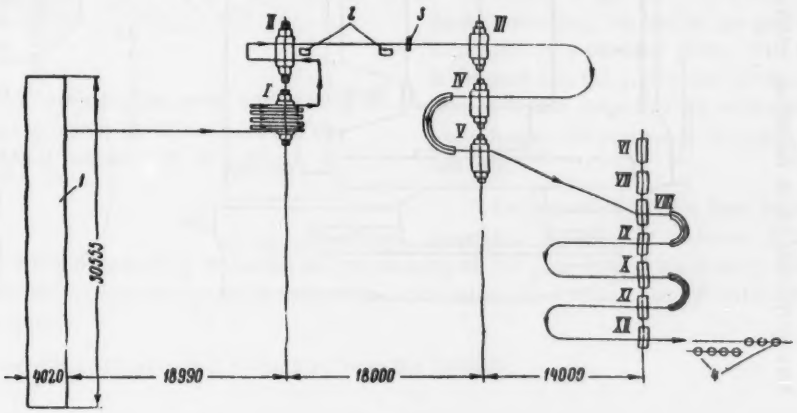


Fig. 1. Diagram of the layout of the equipment of the mill and the movement of rolled steel: 1) holding furnace; 2) shears; 3) conveying roller; 4) coilers; I-XII) stands

The pass design for periodic section No. 8 remained the same as for the ordinary, 8 mm diameter, wire rod. Some minor changes in the dimension of the intermediate sections are effected by means of adjusting the gap between the rolls. The design dimensions of the pass, the profile of the spiral grooves and the unfolded drawing of the pass for rolling section No. 8 are shown in Fig. 2. The arrangement of the passes is given in Fig. 3. Section No. 8 is rolled from 150 x 150 mm billets supplied by the "Azovstal" Works; the average weight of the billets is 200 kg. The ingot for ordinary wire rod weighs 225 kg. The mean output of the mill per shift is 168 tons and 144 tons respectively, when the ordinary wire rod and wire rod for concrete reinforcement are rolled. The reduced output of reinforced concrete rod is explained by the smaller weight of the billet and a higher metal consumption.

The ingot consumption for the production of ordinary wire rod is 1.120; for the production of reinforced-concrete rod from 25G25 steel, it is 1.142.

If the size of the working floor allowed for a longer rolled piece obtained from reducing stand No. 1, the

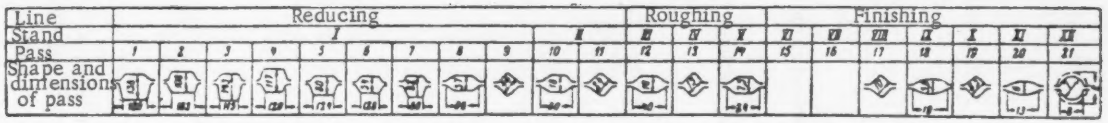


Fig. 3. Arrangement of passes for rolling reinforced concrete wire rod No. 8

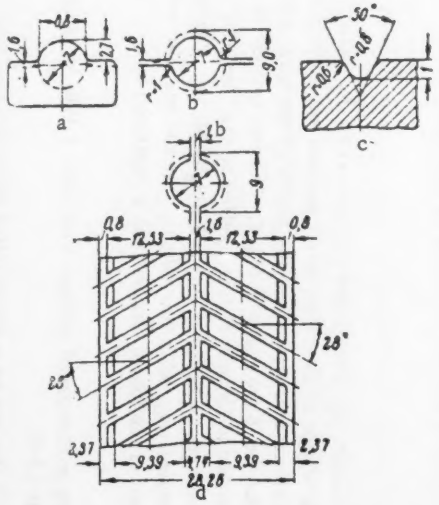
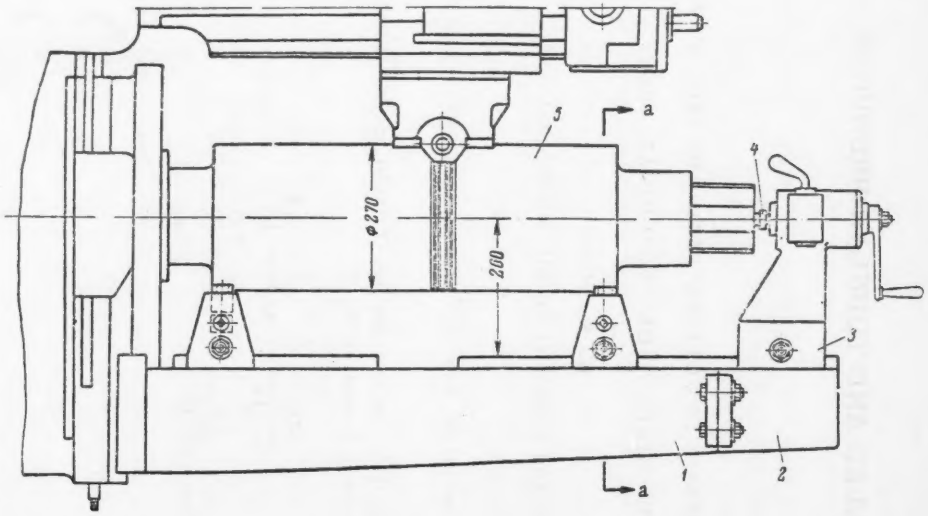


Fig. 2. Design dimensions of section No. 8: a) pass template; b) pass; c) contour of spiral grooves; d) evolution of the pass



Section a-a

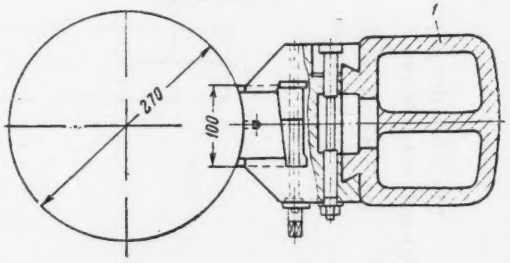


Fig. 4. Positioning of the roll for cutting spiral groove on the " Komsomolets" lathe: 1) stand; 2) adjustable stand; 3) tail-stock; 4) center; 5) roll

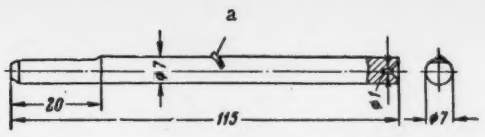


Fig. 5. One-tooth cutter: a) pobedit tool.

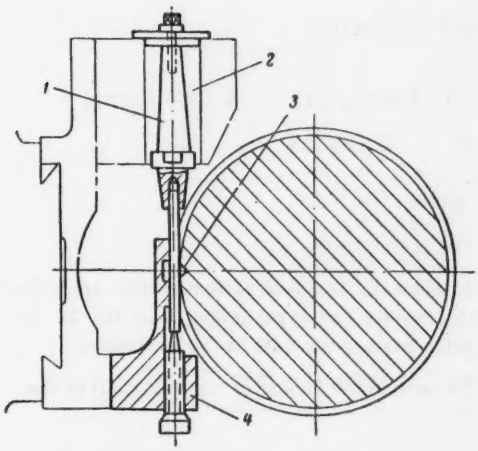


Fig. 6. Method of mounting the cutter and bearing on the gear-cutting machine: 1) headstock of the cutter; 2) spindle; 3) pobedit tool; 4) tailstock bearing.

mean output of reinforcing rod per shift would not be lower than that of ordinary wire rod.

The roll consumption in the process of rolling reinforcing rod from 25G25 steel is higher than for ordinary wire rod.

The main difficulty in mastering the production of reinforcing wire rod was the machining of the spiral grooves in the roll passes. There is no special lathe for this purpose. At our Works, the gear-cutting machine "Komsomolets" (Fig. 4) was adapted for cutting the grooves.

The milling (cutting) of the grooves is done with a one-tooth fly-cutter (Fig. 5). The cutter is made as follows: a mounting, 115 mm long and 7 mm in diameter, is machined from KhVG steel on a lathe. A spiral line is cut on the mounting (the pitch of the spiral is three times the pitch of the spiral grooves).

The spiral line serves as a guide for the tooth of the cutter. A groove is cut along the spiral line on the mounting, the size of the groove being equal to the size of a pobedit* plate. The pobedit plate is inserted into the groove and welded on with copper. It is then shaped on the carborundum grindstone according to the contour of the spiral groove in the roll pass.

To prevent the cutter from breaking during the operation, the shank of the cutter is supported by a bearing. The method of mounting the cutter and the bearing on the gear-cutting machine is shown in Fig. 6. The machine has interchangeable gears of tooth ratios which allow for a wide range of variation in groove cutting on the roll body.

The number of spiral grooves is calculated from the formula:

$$Z = \pi D/l ,$$

where Z is the number of grooves; D is the diameter of the roll body; l is the pitch of the grooves.

The spiral grooves, on triple-thread lines, can be cut by a one-tooth cutter if their number in the pass groove around the roll is not a multiple of three.

Four roll grooves per shift can be machined with the one-tooth cutter.

* Pobedit = tungsten carbide-titanium carbide alloy.

IMPROVEMENTS IN THE EQUIPMENT OF THE ROUGHING STAND OF THE HEAVY-SECTION MILL

N. F. Protasov, V. P. Khlebnikov, A. I. Sikorskii, V. V. Gonchar, V. E. Stefanov and L. I. Boldyrev

The "Azovstal" Works

In the course of the operation of the rail-structural mill, where all beams of various section are rolled in closed passes, it was found that during the rolling of low-number beams, and in particular beam No. 20, the rolled piece frequently knocks out the guides screwed to the guide bar and the mill has to be stopped.

The guide bar (Fig. 1) is a cast-steel block fastened at its ends to the chocks of the lower roll of the roughing stand.

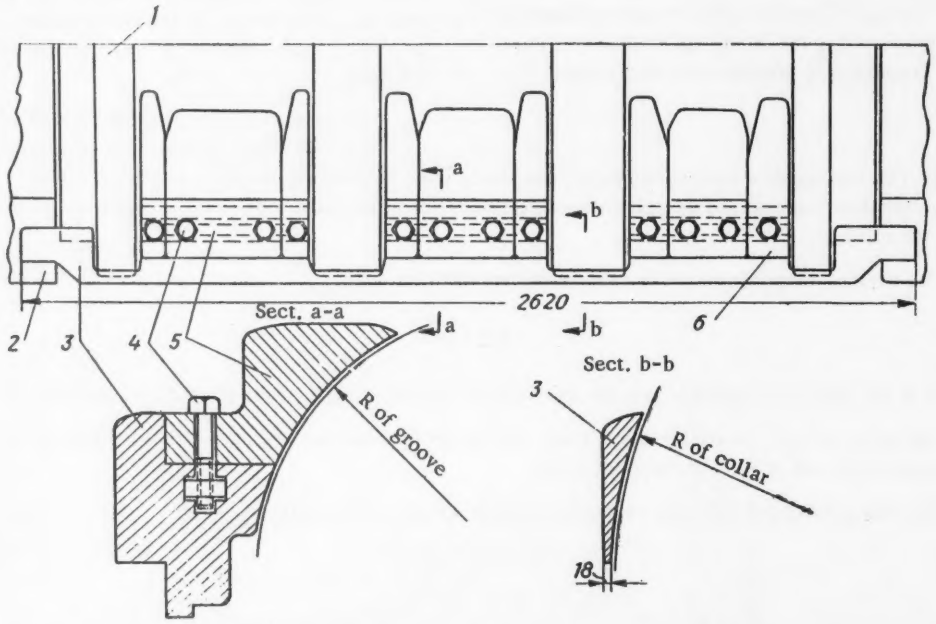


Fig. 1. Roll accessories for beam rolling: 1) roll; 2) chock of the lower roll; 3) guide bar; 4) bolt and screw; 5) web guide; 6) flange guide.

In front of the passes there are lugs with cross-shaped recesses for the nut and bolt with which the guides are fastened to the bar. The bar is set in the slots of the chocks when the rolls are prepared for changing, then the guides are positioned and fastened with the bolts. The lower chocks are joined to each other by means of

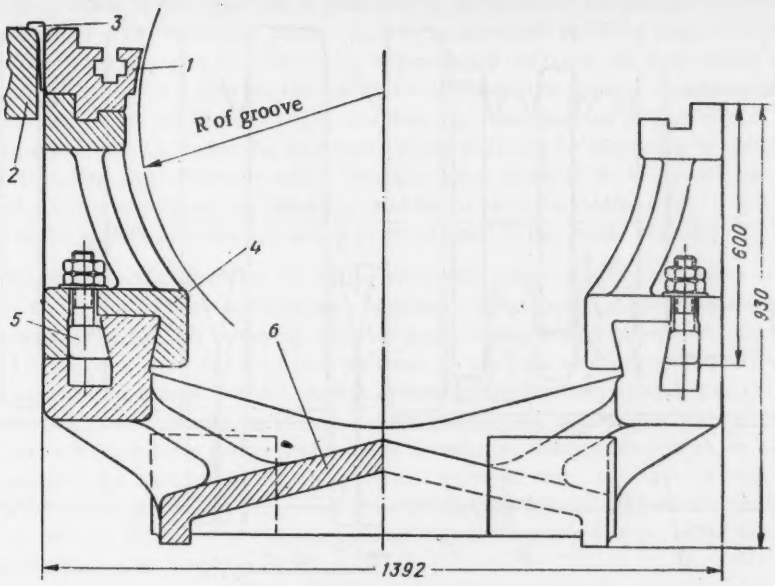


Fig. 2. Roll accessories for beam rolling: 1) guide bar; 2) rest bar; 3) wedge; 4) movable support; 5) bolt with wedge-shaped head; 6) tie beam.

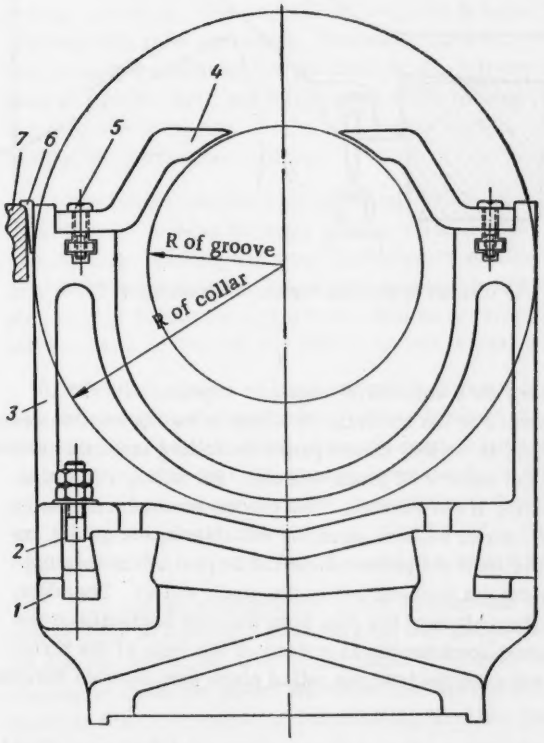


Fig. 3. Roll accessories for rolling small-size girders: 1) tie beam; 2) bolt with wedge-shaped head; 3) movable support; 4) guide; 5) bolt; 6) wedge; 7) rest.

a tie beam, which is placed on the rails of the roll changing apparatus during the roll changing, and are connected to the chain mechanism.

Before the roll change, the upper roll is placed, by means of props and suspension chocks, onto the lower roll assembled together with the guide bar. Both rolls, together with the assembled bar, are inserted through the window of the housing and fixed in the working position.

As shown in Fig. 1 (section b-b), the shaped bar in front of the pass collars of the lower roll has cross sections which cannot withstand large stresses resulting from shocks during rolling operations. The cross-section area can be increased only by reducing the mean diameter of the rolls, thus considerably reducing their durability since an increase in the thickness of the bar by 10 mm entails a reduction of the mean diameter of the roll by 20 mm. Hence, the bar in front of the pass collars is made as thin as possible (15-20 mm). This thickness is adequate to support the bar's own weight only.

To absorb shocks during rolling, an auxiliary bar – in addition to the guide bar – is mounted on special lugs on the housing and it absorbs the shocks via wedges driven between the two bars. In addition there is a special attachment (Fig. 2), supporting the bar in front of each

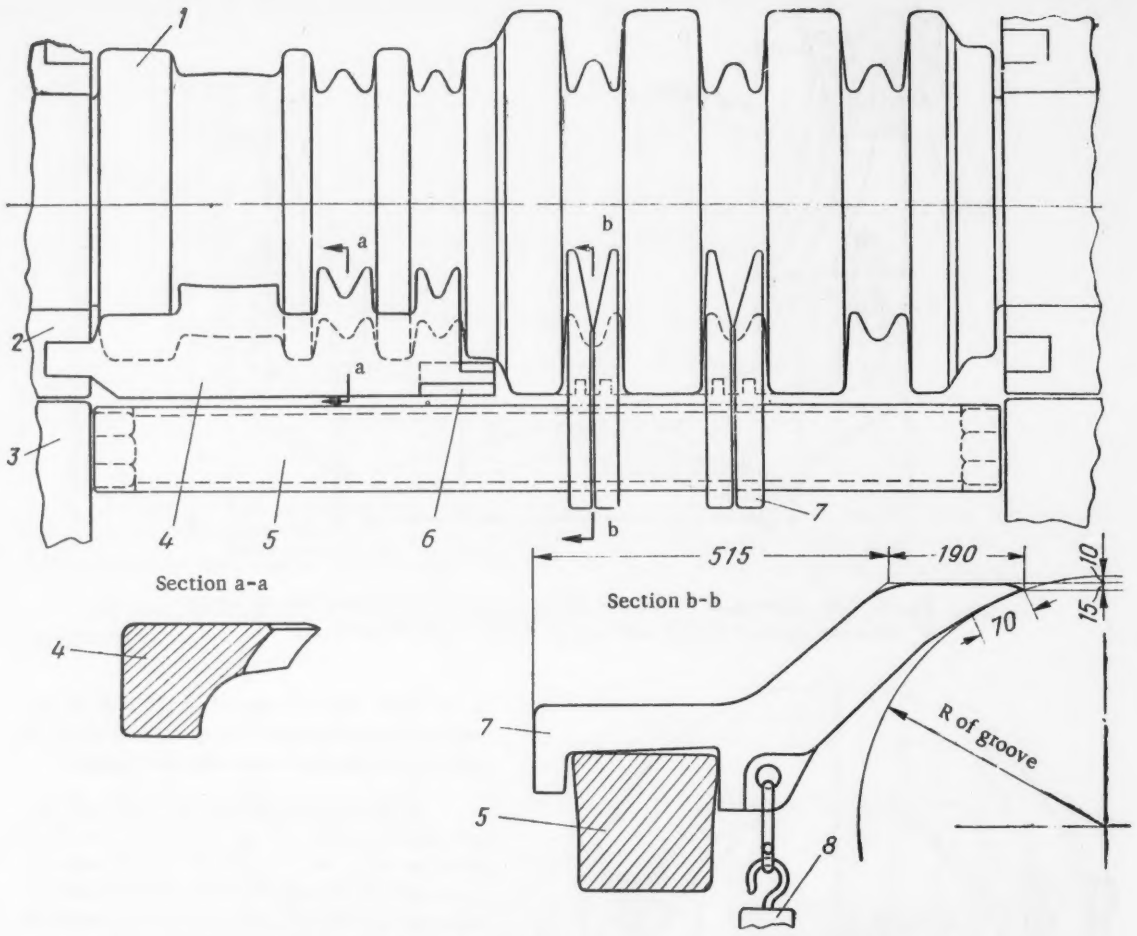


Fig. 4. Guide arrangement for small-size beam rolling: 1) roll; 2) lower roll chock; 3) housing; 4) "slab" bar; 5) trapezoidal bar; 6) support; 7) guide; 8) load.

pass. The attachment consists of movable supports mounted on a dovetailed ridge cast together with the tie beam connecting the lower chocks. The supports are fastened to the tie beam by means of two bolts with wedge-shaped heads. Such a design of the guides makes it possible to employ closed passes for rolling large size beams (Nos. 30-55) and the rolling can then be speeded up and the number of passes reduced. For rolling small size beams (Nos. 18-16), however, this method of guide mounting is not reliable. The guides, screwed onto the bar with bolts, cannot be pressed with their front end against the roll because when the roll rotates, the guides, under the great pressure exerted by the tightened bolts, would wear the passes; under the impact of the rotating roll the mounting of the guide gets weakened and the guides get knocked out by the girder rollers. Therefore, a minimum gap is left between the tip of the guide and the surface of the pass from the very beginning of the rolling operation. In the course of rolling, this gap increases considerably as a result of the wear of the textolite bearings and the deformation of the chocks and the rolls. Scale from the rolled piece gets jammed between the guide end and the roll.

When small-size beams are rolled, owing to their limited rigidity, they are taken round the lower closed rolls, and on contacting the tip of the guide, which does not fit tightly against the pass, knock it out, and thus may cause a breakdown and a prolonged stoppage of the mill.

At one of our works, closed top rolls are used owing to the small opening in the lower part of the housing.

The taking-on of rolled metal by the upper roll is prevented by an increased top pressure in conjunction with an increased groove and small drafts in the last passes. Such an arrangement of closed passes is uneconomic in the rolling of low-number girders owing to the uncertainty of preventing the upper roll from taking-on the rolled metal and the lowering of the mill output because of the underfilling of the passes. In addition, preserving the arrangement of alternating open and closed flanges, one must use closed top and bottom rolls of the first and the second finishing stand, and this makes the adjustment of the mill and the tightening of the housing more complicated. It is, therefore, more advantageous to have the closed passes in the lower roll; then the closed part of the passes of the first and the second finishing stand has to be in the middle rolls. It is more convenient to have the guides at the middle enclosed roll which is not adjusted in the course of rolling.

To provide the best possible conditions for rolling small-size girders when closed passes are in the lower roll of the reducing stand, two different arrangements of guides were proposed. In the first arrangement, the guides are not fastened to the bar, but to special movable supports mounted on dovetailed ridges in front of the pass (Fig. 3). The supports are tightened to the tie beam by two bolts with wedge-shaped heads. Small wedges are driven between the support and the rest bar in order to improve the reliability of the equipment. This method of mounting is not different, in principle, from the existing one, but the absence of the bar between the roll collars and the housing makes it possible to increase the bottom pressure at the same roll diameter which is smaller than the diameter of the strong top roll by 30-40 mm. This fact, in conjunction with an increased depth of the passes, provides rolling conditions approaching those of the reducing stand with closed top roll without any delivery guides. The intention was to reduce the pressure of the rolled piece on the guides to a minimum and to prevent the breakage of the guides.

In the second arrangement, a trapezoidal cross-section bar, instead of the auxiliary rest bar, is mounted in the recesses in the housing similarly to the guide bars of the finishing line (Fig. 4); a curved guide, pressed against the roll by means of a weight, is mounted on the bar. The shape of the guide fully conforms to the operating conditions. The rear end of the guide is below the extended guards of the manipulators and does not interfere with their operations. The raised front end of the guide is 10 mm below the top point of the pass so that favorable conditions are provided for the delivery of the piece from the roll. If the front end of the guide were at a lower level, the rolled beam, while tending to surround the lower closed roll, would press at a larger angle against the guide, i. e., with a bigger vertical component of pressure, thus making the operating conditions of the guide more difficult.

The guides, pressed against the roll by means of a weight, are much simpler, more reliable and cheaper since there is no need for every section rolled to make a massive cast bar with strengthening attachments whose manufacture – casting and rather complicated machining – is very expensive. In addition, as there is no bar between the collar of the roll and the housing, it is possible to make full use of the housing window and to employ rolls of 30-40 mm larger mean diameter; hence, the possible number of the dressings (machining) of the roll increases by 30-40%, the life of the roll increases and the roll consumption falls.

With this method of guide mounting, it is not possible to carry out several passes in the same groove because of the danger of guides being drawn between the rolls. However, in the last grooves of the reducing stand there is no need for this since there the most important thing is an extensive reduction in the thickness of the flanges and this is done much more conveniently in different grooves. In the first box and edge passes with gaps between the rolls where the billet is passed several times, a "slab" made at the plant, is mounted between the roll and the trapezoidal bar (Fig. 4). The "slab" is fixed with one end in the recess in the roll chock in place of the guide bar, and with the other end in a special support.

The second arrangement, found simpler and more reliable in operation, was accepted. Hence it was possible to develop a more rational roll design including closed passes in the reducing stand for rolling No. 16 and No. 18 beams. The total number of grooves, their distribution in the stands of the finishing line, the number of times the pieces are turned and the number of passes have remained the same. Owing to greater drafts in the closed passes of the reducing line, the finishing line has been relieved of about 20-25% of work.

Since March, 1957, the rolling of beams with the new arrangement of passes showed that the grooves are more durable, the output is higher, the breakage of rolls is reduced to a minimum and the web can be rolled at negative tolerances, thus providing conditions for saving steel.

The new guide arrangement is especially important for the production of thin-wall sections where the

main work on the formation of the section has to be done in the reducing stand. For instance, when thin-walled No. 16 beam is rolled, the rigidity of the section leaving the last pass of the roughing stand is more than 1.5 times less than the rigidity of the normal No. 16 beam and the flanges at the edges are nearly twice as thin (9.8 mm). Such a section tends to jam in the closed pass, and especially reliable guides which adjoin well to the pass, are required for the removal of the jammed section from the rolls. The second method of guide arrangement has justified itself during the production of thin-walled No. 16 beam.

The guides of the design described above for the reducing stand have been in operation on beam rolling for one year. There were no breakages of guides during that period.

EXPERIENCE IN THE USE OF MILL ROLLS

Roll Design Engineer, G. D. Feigin

The durability of rolls has a substantial effect on the quality of the surface and the accuracy of the dimensions of the sections rolled, as well as on the duration of idle periods during roll changes. Roll consumption constitutes, on the average, 5-10% of all manufacturing costs and affects the cost of production markedly.

The rail-structural mill of our Combine achieved considerably better results, compared with similar mills of other works, with regard to the life of rolls and the consumption of rolls per ton of rolled product. The mill consists of two rolling trains, the 900 line consisting of one roughing two-high reversible stand with rolls of 2300 mm barrel length, and the 800 line consisting of two three-high stands (intermediate and prefinishing) and one two-high finishing stand. The barrel lengths are 1900 mm and 1100 mm respectively.

At the 900 stand, forged rolls of steel 50, and at the 800 stand, cast-iron rolls or rolls made of steel 60KhN, are used.

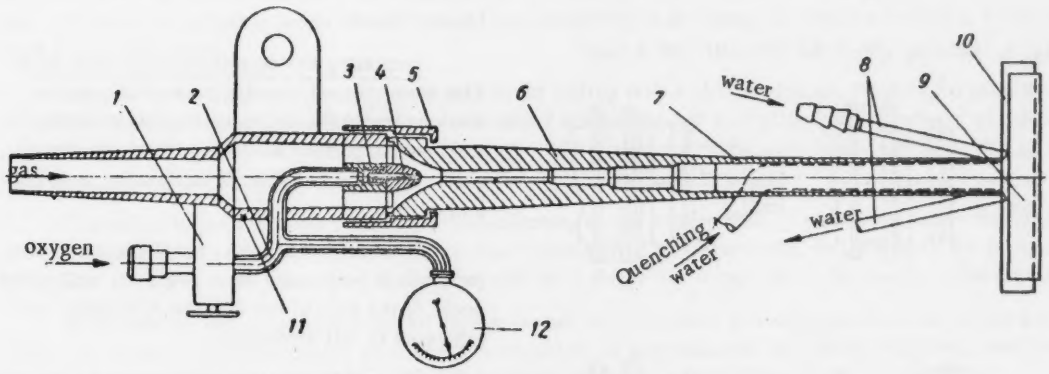


Fig. 1. Burner for surface hardening of rolls: 1) oxygen valve; 2) oxygen pipe; 3) injector holder; 4) injector; 5) holding nut; 6) diffuser; 7) end piece; 8) water inlet and outlet tubes; 9) burner nozzle; 10) water sprayer; 11) housing; 12) manometer.

In recent years, roll consumption in the rail-structural mill decreased considerably. While in 1951 the roll consumption was 3.7 kg per ton (7.67 rubles) of rolled product, in 1957 it was 1.73 kg (2.61 rubles).

We achieved this reduction in roll consumption and an increase in roll durability by adopting several measures described in this article.

Correct choice of roll material. It is best to use cast-iron rolls. They have a higher durability compared with steel rolls and are 2 or 3 times cheaper.

Thus, the change from steel to cast-iron rolls on the intermediate stand of the 800 mill during the rolling of R-43 rails resulted in an increase in roll life during one campaign from 4-5 to 9-12 thousand tons of rolled product and a reduction of 40% in roll consumption in terms of weight and of 80% in terms of money.

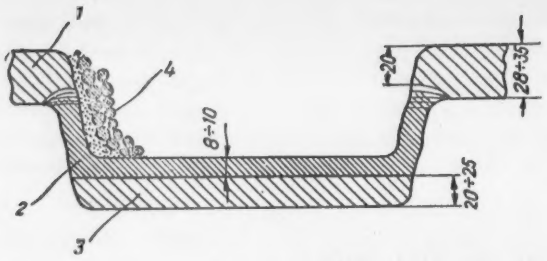


Fig. 2. Building up of the side walls of the box pass: 1) collar; 2) working layer; 3) intermediate transition layer; 4) asbestos.

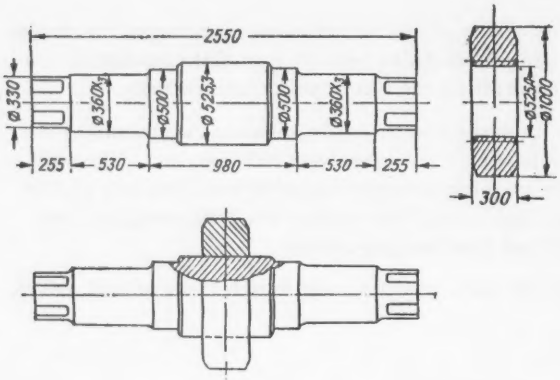


Fig. 3. Working roll of the 800 mill with a hoop.

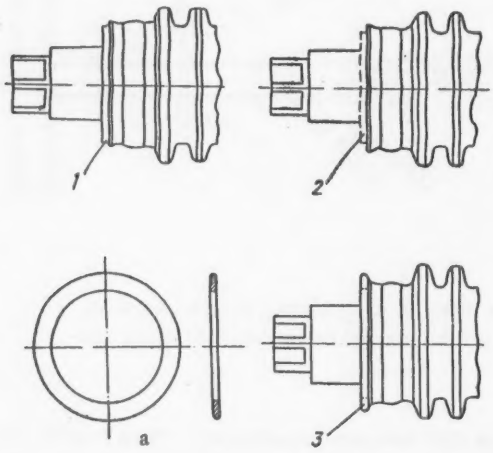


Fig. 4. Steel hoop placed on the roll: 1) broken off collar; 2) machined roll; 3) collar in place; a) hoop.

There were, however, occurrences of collar breakages. After the best width of the collars had been found and the correct temperature and speed of rolling had been observed, the collar breakages ceased.

We use cast-iron rolls in the intermediate stand also for rolling squares and tractor shoes where the depth of the passes is quite considerable. It is planned to use magnesium-alloyed cast-iron rolls in the IInd stand for rolling Z-beam 310.

We attach great importance to the sorting of rolls according to hardness. In one group of rolls the difference in hardness of individual rolls does not exceed 20-30 units of Brinell hardness number.

When cast-iron rolls are used on all three stands of the 800 mill the hardness of the rolls in the intermediate stand is not more than 280 H_B, in the prefinishing stand it is up to 330 H_B, and in the finishing stand it is up to 420 H_B. The conditions of deformation, the temperature of the rolled metal and the width of the collars are taken into account when the choice of the roll hardness in each individual case is made. The hardest rolls are used for rolling rounds and squares, medium-hard rolls are used for H-beams and soft rolls for channel beams.

Increasing the durability of the steel rolls. The main method, (used systematically at our Works since 1953), of improving the durability of steel rolls is surface hardening by means of the multi-flame burner (Fig. 1) using coke-oven gas and oxygen.

Open collars of passes for H-beams, passes for channel beams and other passes, as well as the necks of the rolls of the 900 and 1150 mills, are subjected to roll hardening.

The surface hardening increased the durability of rolls by a factor of 1.5-2 and approximately doubled the life of the textolite bearings. The bearings of the 1150 mill now serve for 3-4 months and those of the 900 mill last for up to 8 months.

A very promising method of improving the durability and reducing the consumption of steel rolls is the restoration of the diameter and width of the passes and an improvement in the wear-resistance of the working layer by the automatic building up of metal with the use of flux. The plating and hardening are carried out on a roll-lathe specially adapted for that purpose. The plating of the horizontal surfaces and inclined walls of the box passes has been mastered (Fig. 2).

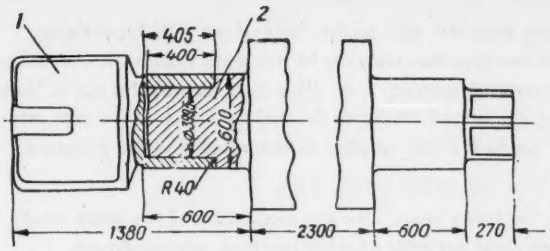


Fig. 5. Placing the "fork" on the roll: 1) "fork" in place; 2) roll of the 900 mill.

At present, the width of the most worn-out collars of box passes is built up with 30KhGSA steel wire and the height of the collars is built up with 08kp steel wire. At the same time, powder wire PP3Kh2V8 is used for building up the working layer of box and shaped passes and for improving its resistance to wear. When, however, this method of plating is used, the machining of built-up rolls becomes rather difficult and the gripping power of the rolls deteriorates owing to a decrease in the friction coefficient between the rolled steel and the rolls. Apparently, according to the practice at the KMK, to improve the grip it is necessary to build up bands with the same powder wire on the roll parallel to its axis.

The gripping power of rolls on the 900 mill is also increased by ragging the roll with spiny pads.

The frequent complete restoration of the passes makes it possible to cut the consumption of steel rolls considerably. In addition, rolling at a constant maximum diameter of rolls results in an increased output owing to the increased speed of rolling and better conditions of gripping.

Increasing the durability of cast iron rolls. The durability of cast iron rolls has been increased by using low-magnesium rolls in the Ist and IInd stand of the 800 mill.

The advantages of these rolls are: a) a uniform distribution of cementite through the whole cross section results in a greater hardness of dressed rolls; b) the spherical form of graphite inclusions increases the strength of the rolls, owing to the continuity of the matrix, and reduces the wear of the pass; c) a higher friction coefficient enhances the gripping power of rolls; d) a higher durability of the passes, in which a reduction in the vertical plane takes place.

Magnesium rolls are used at our Works mainly for rolling rails and tractor shoes. For flanged sections, rounds and squares it is more economical to use ordinary chrome-nickel low-alloy rolls of rather high hardness since it was found in the course of operation that large-size magnesium rolls were brittle (probably due to an imperfect method of casting) and tended to chip even under very light impacts.

The rolls with cast grooves were found unsatisfactory at our Works. The durability of these rolls during the campaign was 2 or 3 times higher than the mean durability of plain cast rolls, but, owing to the inadequate strength of the core, there were cases of fractures and not a single roll lasted till it was completely worn out.

At present, in connection with radical improvements in the method of casting grooved roll at the Lutugino Works, we ordered and have already received a consignment of experimental rolls for the finishing stand for rolling rails and channel beams and these rolls will be tested in the very near future.

Compound rolls. For rolling light-section H-beams, the four-roll universal stand, instead of the two-high finishing stand, is used. If horizontal rolls made of steel are employed in this stand, frequent roll changes are necessary because of their low durability.

In order to extend the service life of steel rolls, compound rolls consisting of a steel axis and a cast iron hoop, 0.3 mm smaller in diameter than the roll and placed on the roll hot (Fig. 3), have been adopted.

If the nonworking end collar breaks it is replaced by a steel hoop, 0.5 mm smaller in diameter than the roll, set up hot (Fig. 4).

Utilization of worn out rolls. With the object of reducing roll consumption per ton of rolled product, worn out rolls are frequently used at our Combine as initial material for rolls of a smaller diameter.

The worn out rolls (made of 60KhN steel) of the thick-plate mill are used as initial material for open rolls of the 800 mill; the worn out rolls of the 800 mill are machined into starting material for the rolls of the 500 roughing stand of the spring mill at the Chusovskoe Metallurgical Works, for the hoops of the roller-straightening

machine at the Salda Metallurgical Works and for the rolls of the wheel-rolling mill.

Considerable savings have also been achieved by using worn out rolls of the thick-plate mill for making compound closed rolls for the 900 mill. The difficulty was the fact that the rolls of the plate mill have a wobbler spindle whereas the rolls of the 900 mill have a universal coupling spindle, i. e., they have no wobbler but a "fork" at the driven end. The difficulty was overcome by placing the heated "fork" of the 900 mill roll on the roll, machined from the worn out roll of the plate mill, the "fork" being 0.4 mm smaller in diameter than the prepared roll.

The composite rolls have been working satisfactorily for three years. For the production of the more rarely rolled sections (e. g., undercrane rails), rolls machined from worn out rolls of other sections, are employed.

The finishing rolls for rounds and square sections are machined from worn out closed-pass rolls for channel beams.

Improving the pass and roll design. In the course of operation the diameter of the rolls of the 900 mill has been increased from 960 mm to 1010 mm. Better conditions for gripping the rolled piece were thus provided.

The radius of the chamfers of the rolls of the 800 mill has been increased from 50 mm to 70 mm and this has resulted in a substantial reduction in breakages of the cast-iron roll necks.

Improvements in pass design played the main part in the reduction of roll wear. In the process of rolling flanged sections, when the metal is frequently displaced from one part of the pass to another, excessive frictional forces appear and cause local wear to some parts of the pass. Thus, it was found during the rolling of H-beams No. 24 and No. 55 that the pass wears out opposite the flange which undergoes the smaller side reduction. The side wall of the pass in front of the closed flange showed excessive wear. After the side draft in the closed flange had been increased, the wear of the pass was eliminated.

The change over to the angular method of rolling rails in 1951 resulted in a reduced consumption of rolls. At present, the change over to rolling channel beams and angles by the butterfly method and with greater depth of passes is being carried out, and it is conducive to a reduction in the cost of a set of rolls (closed-pass rolls have a smaller diameter) and a reduction in their consumption.

For rolling H-beam No. 55, a 5-roll set instead of the 3-roll set with two combined passes, 4 and 5, and an idle pass in the lower roll under pass 6, was introduced. The bottom roll of the 5-roll set has, instead of an idle pass, a second (doubled) pass 5, and the middle and the top rolls are accordingly machined. When they are to be used the lower roll is turned through 180° about the vertical axis. In this way, two three-roll sets are fully replaced by one five-roll set.

Use of rolls at the mill. The design envisaged the cooling of rolls with water from a tank mounted in the top of the housings and provided with appropriate openings. It was found that the amount of water was not adequate and additional water had to be provided.

The introduction of an additional holding furnace in 1956 made it possible to increase the mean temperature of the rolled steel and thus improve the operating conditions of the rolls. Sometimes, during the rolling, there are cases of the rolled piece stopping between the rolls (jamming, etc.). The part of the piece jammed between the rolls is sprayed with water and cooled quickly. When rolled, such pieces cause roll breakages. In order to have the water switched off rapidly, a pneumatic tap, instead of one operated by hand, has been adopted; at the 900 mill, where there are no workers, the water is switched off at the control desk.

Owing to the introduction of these improvements, the consumption of rolls per ton of rolled product has been reduced by 5.06 rubles, i. e., 60%.

NEW METHOD OF CARD WIRE PRODUCTION

Cand. Tech. Sci. Ia. Kh. Sartan

The "Proletarskii Trud" Works

Card wire is used for the manufacture of card belts for carding machines. The technological process of making card wire consists of the following operations: pickling wire rod in sulfuric acid solution, washing in hot water followed by washing with a cold water stream from sulling lime treatment in boiling lime solution; drawing first rod wire of 2.5, 2.2 and 1.8 mm with the use of dry lubrication (soap powder); intermediate annealing after the first draft, in accordance with the accepted procedure, ensuring an ultimate tensile strength of σ_b = 32 to 38 kg/mm^2; pickling the annealed wire in sulfuric acid solution; washing in hot water followed by washing with a cold water stream from a fire pump; sulling; lime coating in boiling lime solution; drying in drying chambers, drawing from 2.5 mm diameter to shaped section 1.8 x 1.2 mm; from 2.2 mm diameter to 1.6 x 1.0 mm and from 1.8 mm diameter to 1.2 x 0.8 mm.

Each group is subjected to 5 drafts, the last three drafts are effected in shaped die with the use of emulsion lubricant. The preceding drafts are effected in circular dies with dry lubrication (soap powder). In addition to emulsion lubrication, the wire is treated with copper sulfate solution before each wet drawing.

The finished wire should have an ultimate tensile strength of σ_b = 55 to 70 kg/mm^2 and should withstand the following number of repeated bendings through 90°, the radius of the bend being not less than 5 mm; three for 1.8 x 1.2 mm wire; four for 1.6 x 1.0 mm wire and five for 1.2 x 0.8 mm wire. The emulsion used as lubricant is made of soap (7.5 kg), flour (sweepings) (10.0 kg) and water (500 kg).

Before the first wet (emulsion lubricant) draft the wire is dipped in aqueous solution of 7.0-8.0% sulfuric acid and 2.0-2.5% copper sulfate. Before subsequent wet drafts, an aqueous solution of 3.5-4.5% of sulfuric acid and 2.0-2.5% of copper sulfate is used.

We have developed a new technological process of card wire manufacture, involving only dry drawing in circular as well as shaped dies.

The previous arrangement of drafts for shaped cross section wire cannot be considered satisfactory, since frequent fractures occurred in all drafts and it was impossible to obtain the correct design height of the cross section.

In our tests we used wire rod made of steel grade St. 2.

The following arrangement of dies was accepted: circle – oval No. 1 (approximate) – oval No. 2 (approximate) – final card wire section.

The test batches of card wire made by the new method conformed to all the standard specifications regarding shape, dimensions and mechanical properties.

The new method includes the following operations: the preparation of the surface of the 6.5 diameter wire rod for drawing (pickling, cold water rinsing, lime coating); the first dry drawing (soap powder as lubricant) from 6.5 mm diameter to 2.5 mm diameter for 1.8 x 1.2 mm card wire, and from 6.5 mm diameter to 2.2 mm diameter for 1.6 x 1.0 mm wire; annealing; surface preparation (pickling, rinsing with cold water and lime coating); drying; the second draft from 2.5 mm diameter to 2.05 mm diameter for 1.8 x 1.2 mm wire and from 2.2 mm diameter to 1.85 mm diameter for 1.6x 1.0 mm wire; pickling and washing; copper sulfate treatment;

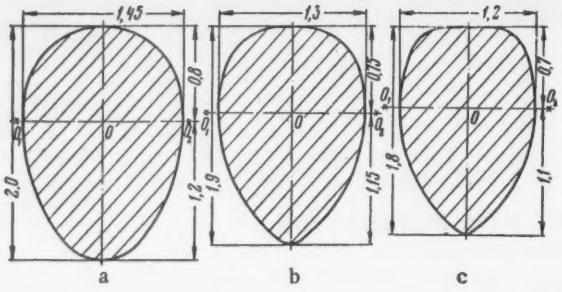


Fig. 1. Consecutive passes in the drawing of 1.8 x 1.2 mm card wire: a) first intermediate oval; b) second intermediate oval; c) final section.

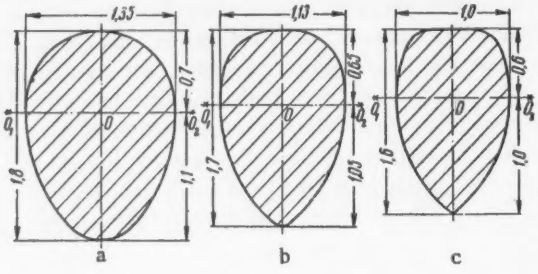


Fig. 2. Consecutive passes in the drawing of 1.6 x 1.0 mm card wire (notation as in Fig. 1).

washing and lime coating; drying; drawing the approximate ovals: a) from 2.05 mm diameter to 2.0 x 1.45 mm oval followed by the 1.9 x 1.3 oval mm wire for 1.8 x 1.2 mm wire and b) from 1.85 mm diameter to 1.8 x 1.35 mm oval followed by 1.7 x 1.13 mm oval for 1.6 x 1.0 mm card wire; pickling and washing; copper sulfate treatment; washing and lime coating; drying; drawing the final wire: a) 1.8 x 1.2 ± 0.05 mm card wire from 1.9 x 1.3 mm oval section and b) 1.6 x 1.0 ± 0.05 mm card wire from 1.7 x 1.13 mm oval; wire testing and inspection by the OTK; greasing, packing and storing the wire.

Pickling is always done in sulfuric acid solution with an addition of ChM. The initial concentration of the solution is 8-18%, the temperature is 45-75°C and the duration of pickling depends on the concentration of the solution: 20-60 min for wire rod; 10-20 min for annealed intermediate product and 5-8 min for the wire before the copper sulfate treatment. Rinsing and lime coating is done in the usual, commonly accepted manner.

The wire should be dried in a drying chamber, but because the drying chamber was out of order during the tests the wire was dried on the top of the annealing furnaces.

The 2.05 diameter and the 1.85 mm diameter process wire is dipped in aqueous solution of sulfuric acid (4-6%) and copper sulfate (3-5%) before the first shaped draft. Copper sulfate treatment is repeated before the final draft. The wire is kept in solution for 1-3 min.

The 2.05 mm diameter and the 1.85 mm diameter process wire are annealed in Sh0-130 electric furnaces at 740°C for 1.5 hrs. For cooling, the wire is transferred to cooling pits. This method of annealing ensures the ultimate tensile strength of 38-43 kg/m^2.

The drawing of 2.5 mm and 2.2 mm process wire from 6.5 mm diameter wire rod is done in an ordinary circular hard-alloy die by the following steps: 6.5-5.1-4.0-3.15-2.5 mm at a speed of 450 m/min on the 4/550 wire-drawing frame, and from 2.5 mm diameter to 2.2 mm diameter at a speed of 88 m/min on the 1/600 or 1/700 frame.

The annealed process wires are drawn in ordinary dies on the 2/350 frame in the following steps: a) 2.5-2.24-2.05 mm and b) 2.2-2.0-1.85 mm.

Further drafts are carried out with hard-alloy shaped dies in the following steps: a) 2.05 mm diameter – 2.0 x 1.45 oval (approx) – 1.8 x 1.2 mm card wire section and b) 1.85 mm diameter – 1.8 x 1.35 mm oval (approx) – 1.7 x 1.13 mm oval (approx) – 1.6 x 1.0 card wire section.

The drafts adopted made it possible to have, after the first shaping draft in which the approximate intermediate oval section is formed, a more or less uniform reduction on all sides. This assured a regular drawing through the shaped dies. The oval (approx) process wire was drawn at 96 rpm and the final wire was drawn at 48 rpm.

The drawing of wire through shaped dies was a smooth operation; there were no fractures of the wire when it was drawn through the intermediate oval dies and few fractures occurred at the finishing die.

The shape and dimensions of the wire were in full agreement with technical specifications.

The shaping tools for filing the shaped dies are made by the same method as before, i. e., by 1) grinding a cylindrical rod of 5 mm diam. to a taper on a grinding stone; 2) rough shaping of the section by a smooth file; 3) finishing the tool with a barette file.

The manufacture of such dies is very difficult and requires a skilled and experienced gage maker.

Together with the change of the shaped die design which improved the drawing process and resulted in the cessation of wire fractures, the method of making the shaping tool itself was simplified. Two types of shaping tools are employed for making new shaped dies: one of intermediate oval section, and the other – a straight one – corresponding to the shaping section of the die hole. The first tool serves for shaping the die channel and the other for finishing the shaping section. For making the straight tool, wire of the same section is used. The manufacture of the intermediate oval tool consists of grinding a four-sided 16°taper from 6.4 mm diameter process wire and then shaping it by hand with a smooth file to the required dimensions. The shapes and the dimensions of the shaped intermediate sections are shown in Figs. 1 and 2.

According to the report of the "Kardolenta" Works (the user of the card wire) the card wire satisfies technical requirements with regard to its mechanical properties and the cross-sectional dimensions. The new method of drawing (shaped) card wire, dispensing with the use of emulsion, is conducive to better hygienic working conditions and to higher operating efficiency.

The new die design simplifies and facilitates the operations for the manufacture of shaped wire.

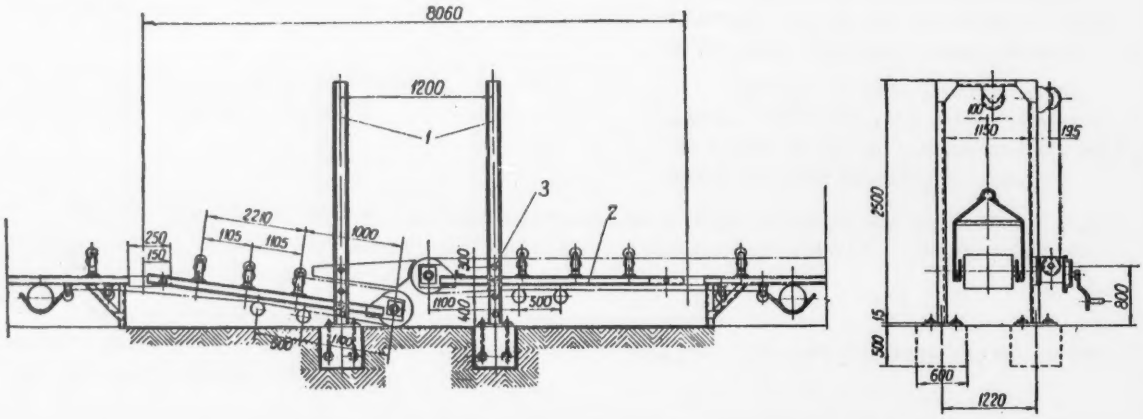
REVERSING STATION OF SECTIONAL CONVEYORS

P. I. Kovalev

Sulin Metallurgical Works

At the open-hearth plant of the Sulin Works, sectional belt conveyors are employed for the removal of brick and slag. When, in the course of operation, it was necessary to reverse the conveyor, workers had to be stationed at the conveyor junctions.

A design for the conveyor-reversing station has been developed at our Works; the design eliminates manual reversing operations and permits the use of the conveyor in both directions.



Reversing station of sectional conveyors: 1) columns; 2) movable sections; 3) holes for fixing the position of the frame.

The station consists of two pairs of columns (1) (see drawing) and two movable sections (2).

When required the positions of the two adjustable sections are interchanged and the electrical motors are reversed.

P. I. Kovalev
Sulin Metallurgical Works

GRIGORII MARKELOVICH IL'IN

During the night of August 18, Grigorii Markelovich Il'in passed away in his 64th year.

G. M. Il'in was born into a peasant family. When 15 years old, he left for Moscow as a hired laborer. In 1918, he volunteered for the Red Army and as a private took part in the legendary Syvash campaign when Vrangel was defeated in the Crimea.

In 1921, G. M. Il'in joined the "Serp i Molot" Works (previously the Guzhon Works) where he was first a furnace attendant and later foreman of the open-hearth plant.

During these years the outstanding abilities of G. M. Il'in as an industrial organizer and a gifted expert revealed themselves G. M. Il'in was the first to introduce high-speed repairs of the open-hearth furnace;by his method, furnaces were repaired in eight days instead of two or three months. While a foreman, he wrote two books which still remain valuable textbooks. He was invited by many iron and steel works to pass on his experience on open-hearth furnace repairs.

In the thirties, G. M. Il'in, as an eminent foreman and furnace expert, was sent abroad. His tour of foreign iron and steel works widened his technical outlook still more. He returned to the plant full of new, creative ideas. In conjunction with engineer M. N. Korolev, G. M. Il'in developed the design of the non-arched open-hearth furnace. Grigorii Markelovich was an untiring innovator. Many a valuable technical improvement was adopted at the Works on his initiative.

Grigorii Markelovich combined his extensive industrial activities wisely with public activities. In 1930, he joined the Communist Party. Without interrupting his work in industry, he studied at the Industrial Academy, giving an example in work, studies and public activities.

From 1938, until his retirement in 1958, G. M. Il'in held the post of Director of the "Serp i Molot" Works. Under his leadership the Works has been successfully accomplishing important tasks on the production of new steel grades and increasing the output of steel.

G. M. Il'in, together with a group of engineers, was awarded the Ist Grade Stalin Prize for work on the development and industrial application of the commercial use of oxygen for speeding up the open-hearth process.

A true Bolshevik man of principle in major and minor issues, exceptionally modest and tactful, and a gifted industrial organizer, G. M. Il'in was held in great esteem. He was elected a Deputy to the Supreme Soviet of the Russian SFSR twice and Deputy to the Moscow Soviet seven times. Several times he was elected a member of the Regional and Moscow Committees of the KPSS.

His selfless work of many years' standing was recognized by numerous State awards. He was awarded three Orders of Lenin, three Orders of the Red Banner of Labor, the Order of the Patriotic War and several medals.

The memory of this outstanding leader, a responsive comrade and a true communist will remain dear to our hearts for many years to come.

N. Bogoliubskii, S. Borisov, N. Grigor'ev, M. Gusarov, L. Gusev, S. Zharov, N. Zhetvin, S. Zalogin, G. Zolotov, N. Inozemtsev, A. Klement'eva, A. Komarov, V. Kosmachev, V. Laptev, V. Lomonosov, A. Mikhailov, I. Novikov, M. Pertsev, I. Prokopovich, I. Romanov, R. Rublinskaia, G. Sviridov, G. Sotnikov, A. Subbotin, I. Turtanov. S. Chesnokov, K. Chichkin, I. Chikhanov and others.

FROM THE BULLETINS OF THE SOVNARKHOZES

HOURLY OUTPUT REGISTER

On the proposal of a senior engineer of the "Uralmetallurgavtomatika," I. I. Kuznetsov, and a mechanic of the KIP and Automation plant, I. G. Abaturov, a register of the hourly output of finished product has been made and set up at the 370 rolling mill of the Chusov Metallurgical Works.

The register counts the number of rolled billets and records it every hour on a chart. Thus, the output of the mill can be evaluated from the actual production in each hour instead of from the average hourly output per shift.

A cash register which was available at the Works was adopted as the counting and recording device; an attachment which allowed the resetting of the counting and recording apparatus to zero reading was fitted to the register. Printer's ink is used in the recording apparatus. The tape transport mechanism is taken from a recording meter – a flowmeter or a self-recording galvanometer – and the standard recording chart, 135 mm wide, moving at 200 mm/hr, is used.

The hourly register can be used for output control for any hot-rolling process by setting up a photoelectric relay as indicator. The register may also be set up for the control of cold products. In that case, a flag indicator or an end indicator and a photoelectric relay with an illuminator may be used.

"INDUSTRIAL AND ECONOMIC BULLETIN" No. 7, 1958
SNKh* of the Perm Economic Region.

A TRAP FOR SEPARATING PIG IRON FROM SLAG

On the proposal of the blast-furnace foreman, N. V. Rudakov, a runner with a trap and a siphon for separating liquid ferromanganese from slag during the tapping of the ferromanganese and the slag from the furnace has been set up at the Novo-Tula Metallurgical Works.

The runner operates on the same principle as a similar siphon trap set up on the main pig iron runner at every blast furnace.

The separation of ferromanganese from slag takes place in the following manner: before the ferromanganese is tapped, the siphon outlet is plugged with sand. Passing over the trap the slag loses speed rapidly, and, owing to the difference in the specific weight of the slag and the pig iron, the pig iron separates and collects in the trap. When the trap has been filled up the siphon outlet is pierced with a crowbar, the ferromanganese separates from the slag and is collected in a mold placed at the side of the slag channel, in front of the siphon elevation.

After the tapping, the mold is removed by the crane, the ferromanganese is transferred into a box and transported to the cold pig iron storage as a finished product. An outlet which is opened when the tapping of the ferromanganese from the furnace has been completed, serves for discharging the remaining ferromanganese from the trap and for preventing the trap from "skulling." All inner surfaces of the trap are lined with sand or other fettling material before each tapping of ferromanganese from the furnace.

"*BULLETIN OF TECHNICAL AND ECONOMIC INFORMATION*" No. 3-4, 1958,
SNKh of the Tula Economic Administrative Region.

* SNKh – Sovnarkhoz – National Economic Council (Translator's note).

AN IRON ORE UNLOADER

A new iron ore unloader, intended for transporting the ore to storage, for blending it and delivering it from the storage to the plant, has been designed and manufactured at the S. Ordzonikidze Kramatorska Machine Works. The unloader is a traveling gantry crane which can handle 600 tons per hour. The crane has two grab buckets of 30 tons load-lifting capacity each.

The bridge of the crane is carried by two supports: it is joined rigidly to one of the supports and hinged to the other. Hence, an oblique setting of the bridge in the horizontal plane is possible. At the rigid-support end, the bridge has a cantilever by means of which the ore can be transferred directly from the sea-going ships. On the hinged support side there is also a cantilever with two suspension arms and a discharge hopper. From here, the ore is charged into railroad cars on the trestle by the two cars moving on a track of their own. The cantilever on the rigidly-joined support is 45.9 m long and on the hinge support (on the side facing the blast furnaces) it is 21.5 m long. The movement of the bridge is effected by two drives, independent of each other – a two-track drive under the rigid support and a single-track under the hinged support. The rigid support is mounted on the traveling mechanism with the use of a roller attachment which permits the displacement of the support when the bridge is set in an oblique position.

The bridge of the unloader can travel at a speed of 15.4 m/min. The speed of the grab buckets is 231 m/min. The lifting height of the grab is 31 m.

Special braking devices (rail clamps) make the new unloader very stable. In the upper part of the bridge above the rigid support, a bridge crane of 10 t lifting capacity is set up for operating and servicing the grab buckets.

The total weight of the unloader is 2400 tons.

"BULLETIN OF TECHNICAL AND ECONOMIC INFORMATION" No. 5, 1958
SNKh of the Stalino Economic Administrative Region.

OUTSTANDING METALLURGISTS

V. E. GRUM-GRZHIMAILO

Vladimir Efimovich Grum-Grzhimailo, an eminent Russian metallurgist and the author of the theory of metallurgical furnaces, was born on February 12, 1864, in Petersburg. In 1873, he entered the Petersburg Military Gymnasium (High School) and, after graduating in 1880, began his studies at the Petersburg Mining Institute.

Vladimir Efimovich wanted to be a production engineer. He succeeded in obtaining a scholarship; he made very good progress in his studies, and graduated from the Institute in 1885 as one of the best students. V. E. Grum-Grzhimailo later wrote "At the Mining Institute I got the feeling that I would be a good worker in industry."

After the completion of his course at the Institute, V. E. Grum-Grzhimailo worked for more than a year as an apprentice engineer at the Nizhne-Tagil Works. During that time, he designed and built blast furnace No. 4 for the production of ferromanganese, produced foundry pig iron from Lebiazh'e ore and improved the casting technique at the Works. In November, 1886 Vladimir Efimovich was transferred to the Nizhne-Salda Works and given the post of "supervisor," i. e., technical assistant to the manager. Here he met the inventor of the so-called "Russian bessemerizing" Konstantin Pavlovich Polenov, who was the manager of the Works at that time. Later on, Grum-Grzhimailo spoke enthusiastically about K. P. Polenov, stressing that Polenov made the young engineer grasp the very principles of metallurgy.

In 1889, in the Mining Journal, V. E. Grum-Grzhimailo published his first paper "Bessemerizing at the Nizhne-Salda Works," in which he expounded the theory of "Russian bessemerizing." At that time, gray pig iron, intended for the Bessemer process, was melted in the reverberatory furnace, then poured into the ladle and transferred to the converter for blowing. The tendency was to melt the pig iron as quickly as possible in order to minimize the loss of silicon and manganese which are the main source of heat in the Bessemer process. No attention, however, was paid to the temperature of the metal charged into the converter.

At one time, the melting operation in the reverberatory furnace was prolonged by 1.5-2 hours more than it was supposed to be because the Bessemer shop was not ready to take the liquid pig iron. The foremen concluded that it was impossible to produce steel from this pig iron, since very little of silicon and manganese remained in the pig iron and it became "chilled". However, contrary to expectations, the blowing process took place at such a high temperature that it was necessary to add rail crop ends in order to cool the metal. K. P. Polenov took notice of this phenomenon and the experiment was repeated. Thus, the "Russian bessemerizing" method, based on the use of low-silicon pig iron at high temperature, came into being.

In his article, V. E. Grum-Grzhimailo compared the German, English, Swedish and Russian methods of bessemerizing and showed that the Russian method was advantageous for works where scrap was available. He analyzed in detail the chemical, metallurgical and economical aspects of this process. The article was translated and published in several European journals. The young engineer became a prominent theoretical metallurgist.

In 1891, V. E. Grum-Grzhimailo was sent to Sweden where he studied the Swedish method of bessemerizing, and then to Paris where he acquainted himself with the Bessemer process involving side blast at Rober's Works. In 1895, his article "The Bessemer process in Sweden" was published in the Mining Journal. At a special meeting of the Russian Metallurgical Society, Academician M. A. Pavlov said that even if Vladimir Efimovich had written nothing more than his first two works, his name would still remain famous in the history of steel metallurgy.

V. E. Grum-Grzhimailo continued to work at the Nizhne-Salda Works and published articles: "On the dimensions of the opening of the tuyere and of the blowpipe in blast furnaces," "The steam engines of the Nizhne-Salda Works, their shortcomings and maintenance" and on other subjects. In his articles and notes, he speaks not only as a metallurgist but also as an experienced engineer. He designed a blast furnace, ore-roasting furnaces and peat-gas producers for the Nizne-Salda Works; a producer burning conifers, brushwood and stumps, and an open-hearth furnace for the Verkhne-Salda Works. Every unit which he designed worked successfully for a long time without any repairs.

In 1897, V. E. Grum-Grzhimailo became the manager of the Verkhne-Salda Works. In 1900 he published, in the Mining Journal, the article "A new design for a durable, nonrising roof of the open-hearth furnace" in which he wrote on the method of making nonrising, durable and heat-resisting silica refractory. Developing the ideas of this article, Vladimir Efimovich set up the theory of refractoriness.

In 1903, V. E. Grum-Grzhimailo became superintendent of the Alapaevsk Mining District and in 1907 he took the chair of metallurgy at the Petersburg Polytechnical Institute and left the Urals where he had worked for 22 years. However, on becoming a professor, Vladimir Efimovich continued to keep in touch with industry and metallurgists of the Urals.

In 1905, while still in the Urals, V. E. Grum-Grzhimailo published, in the Mining Journal, an article "The elementary theory of the design of metallurgical furnaces." The article was immediately published as a booklet and became the basis for the development of the hydraulic theory of gas movement, finally formulated in 1910. The theory of Grum-Grzhimailo constituted an enormous advance in the field of metallurgical heat engineering. Vladimir Efimovich proved that the movement of gases in furnaces obeys the laws of mechanics and physics, and he discarded the numerous empirical formulas from the theory of furnace design and put it on a solid scientific basis. The main principles and rules of furnace design, formulated by V. E. Grum-Grzhimailo, are still serving at present as a guide for the furnace designer.

At the Petersburg Polytechnical Institute, Vladimir Efimovich gave his students a course of lectures which he compiled, the basis of the course being the application of the laws of physical chemistry to the processes taking place in the bath of the furnace. He established a course on "Rolling and roll design"; for a better appreciation of the course at the Institute, he set up a steel-rolling laboratory where a working rolling mill model on which the students studied the process of roll design and rolling rails, girders, beams, etc. was installed. Lead was used as experimental material. In addition, Grum-Grzhimailo lectured on "Reverberatory furnaces."

In 1918, V. E. Grum-Grzhimailo went back to the Urals. He worked as consultant at the Nadezhdino Works (now the Serov Metallurgical Combine) and, in 1920, he became Professor at the Urals Polytechnical Institute. In 1924, Grum-Grzhimailo came to Moscow.

At that time, an intensive development of the Soviet iron and steel industry based on the reconstruction of old pre-revolutionary works had begun. The metallurgists felt an acute need for designs of furnaces and heating equipment but there was no central establishment which would undertake the design work. It was uneconomic to place orders for designs abroad and the quality of those designs left much to be desired. On the initiative of V. E. Grum-Grzhimailo, the Bureau for Metallurgical and Heating Plant Design was set up at the Scientific and Technical Department of the VSNKh. The Bureau was later renamed the "Stal'proekt," the State Institute for the Design of Metallurgical Furnaces. Vladimir Efimovich remained in the post of head of the Bureau till his death. About 400 furnaces and various equipment were designed in four years (1924-1928) under his leadership.

From the very first days, the Bureau refused to take State subsidy and was run as a self-supporting establishment. V. E. Grum-Grzhimailo sketched the design and the designers worked out details and prepared final drawings. All employees of the Bureau were engaged on drawings. Grum-Grzhimailo wrote: "How many first-class engineers wanted to become my collaborators. . . . I always gave one and the same answer: "My Bureau

is a small establishment and exists on its own support without a single kopeck of subsidy. Here we all, including myself, work with the pencil. If you can take the drawing-board work – you are very welcome."

Vladimir Efimovich was educated a long time before the Revolution and passionately detested the stiff, formal methods of lecturing which still persisted during the first years after the October Revolution. When one reads his articles "Students' metallurgical practice" and "What young engineers should be like," one is under the impression that the articles were written yesterday and not more than thirty years ago.

V. E. Grum-Grzhimailo wrote in his autobiography: "For any thesis whatever I collect proofs systematically over many years." He told about establishing the hydraulic theory of furnaces: "A number of considerations and observations accumulated in my head step by step and fact by fact. Finally, the problem became perfectly clear to me and I decided to start experimental testing and set about writing a guide for the experiments. So I wrote "The Elementary Theory" and, in the course of this work, I finally defined the conception of the hydraulic pressure of gases – the basis of the whole theory. After my arrival in Petersburg, I prepared a concrete definition of the problems which had to be expressed mathematically; this was done by L. G. Es'man. The final axiom was revealed as late as 1910 and I was filled with joy. A number of separate local investigations followed and the theory as a whole was completed, but the details are still being developed. And so the work occupied the time from 1887 to 1921, i. e., 34 years of continuous effort and thought."

These words give an excellent example of this remarkable scientist's method of working. His capacity for work was enormous; during his life, he published more than 140 works. Among them, apart from articles on metallurgy, mechanical engineering and heat engineering are such works as "The past and future of the Urals' iron industry," "The north-Siberia railway and the economic union of the Urals and Siberia" and other publications in which V. E. Grum-Grzhimailo presented a project of setting up a Urals and Kuznetsk Combine.

Vladimir Efimovich Grum-Grzhimailo died on October 20, 1928. By that day, 130 furnaces and other units, designed under his supervision, were operating at Soviet works, and many furnaces had been built from his designs. This fact constitutes an excellent monument for the remarkable engineer and scientist.

In conclusion, words from the autobiography of V. E. Grum-Grzhimailo, written in 1921, should be quoted: ". . . Each man should appreciate his abilities, should develop them, and should work conscientiously and with all his might, all his life in the direction once chosen. Maybe he will not become a poet, a great scientist or inventor, but he will become an outstanding man, esteemed and respected by his contemporaries, and he will die happy because he has not wasted his talent.

Here lies the secret of a happy life and this is my precept: work and work; then, the time will come when one day you will wake a great man and then you will be able to face your death calmly."

NEW BOOKS

ACHIEVEMENTS OF THE BLAST-FURNACE OPERATORS OF THE MAGNITOGORSK METALLURGICAL COMBINE

Edited by Prof. A. M. Bannykh

Moscow, Metallurgy Press, 1957, 280 pages

At the beginning of the book, the reader is given a general picture of the blast-furnace plant of the MMK, the operating statistics and specific features of the blast-furnace process at the Combine. The first chapter contains a description of the preparation of raw materials and fuels for the blast-furnace operation. The methods, in use at the Combine, of blending the ores are discussed in detail, and the operation of the sinter plants and the coke-and-by-product plant are described.

The second chapter deals with the use of fluxed sinter in the blast-furnace charge: the quality of the fluxed sinter, its effect on the blast-furnace operation and the theoretically well-founded economic advantages of using fluxed sinter.

In the third chapter, the operation of blast-furnaces during the production of low-manganese pig iron is described and a detailed analysis of the operating and economic statistics is given. In the fourth chapter the effectiveness of the use of pressure operation, the method of changing the furnace to increased-pressure operation, etc. are described.

The next chapter contains a description of blast-furnace operation with a high-temperature blast of an increased, controlled humidity. The role of hydrogen and water vapor in the blast furnace is discussed from the theoretical point of view, the results of employing blast of various humidities are given and the change in the blast temperature in relation to its moisture content is shown. At the end of the chapter, recommendations with regard to the operation of the blast furnace at a high-temperature, humidified blast are given.

The sixth chapter of the book deals with one of the most important problems of the blast-furnace industry – the control of the blast-furnace operation from above. The authors give a detailed analysis of the distribution and movement of stock materials and define the principle means of controlling the blast-furnace operation by the system of charging, the level of the stock, the weight of the ore charge and the adjustment of the revolving distributor. The methods of controlling the furnace process from above are discussed here as a means of combating furnace irregularities.

The seventh chapter deals with mechanical and constructional improvements in the equipment of the blast-furnace plant. The improvements in the design of the charging equipment, the change in design of the heating stove burners, hot-blast valves, tuyeres, etc., are described. The scheme for repairs to the blast furnaces at the MMK is also presented.

The role of the blast-furnace foreman – an extremely important problem – is discussed in the last chapter of the book. In this chapter, the extensive experience of foremen at the Magnitogorsk Combine, who work on their own without detailed supervision from the plant management, is described. The successes of the Magnitogorsk blast-furnace operators are due in a great degree to the enhanced role of the foreman.

The book "The Achievements of the blast-furnace operators of the Magnitogorsk Metallurgical Combine" will make useful reading for every blast-furnace worker in our country.

S. Ia Soboleva
Head Librarian of the Technical Library
of the Kamysh-Burum Iron-Ore Combine.

A. G. ROMANENKO

THE TAPPING OF PIG IRON AND DISPOSAL OF BLAST FURNACE SLAG

Metallurgy Press, Moscow, 1957, 248 pages

The book contains a description of the machinery and the organization of the operations in the disposal of blast-furnace metal and slag; the method of calculating the number of hot-metal transfer ladles, the types of ladles and the method of filling the ladle are presented. The author describes the casting machine and its auxiliary equipment – cranes, hoists, etc. – and how the machine is operated. The main features of cold pig iron yard, its equipment and operation are also given.

The author devotes much attention to slag disposal. He describes the design of cinder ladles, methods of slag disposal, methods of calculating the number of cinder ladles required, the organization of slag-transport operations and slag utilization (granulated slag, slag wool, slag felt, and slag block production).

One of the chapters is devoted to the repair of pig iron and slag disposal equipment, i. e., ladles, casting machines, cranes. The main rules for the maintenance of the equipment and safety rules during repairs are given.

The book also contains the operating and economic statistics of pig iron and slag-disposal sections, and the trends in improvements in the design of ladles, casting machines and slag-granulating equipment.

The book is of interest to technical personnel of blast-furnace plants and can be used by university students for their work on blast-furnace production.

A. G.

Ia. M. DOVGALEVSKII

SPECIAL PIG IRONS AND THEIR PROPERTIES

Metallurgy Press, Moscow, 1957, 198 pages

In the first chapter of the book the properties, methods of production and applications of electrotechnical cast irons (magnetic, nonmagnetic and of high electric resistivity) are described. The effect of alloying elements on electric properties of cast iron and the utilization of this effect for the production of pig iron with desirable properties are discussed in detail.

The second chapter, "Stainless cast iron," is devoted to the properties and the methods of the manufacture of cast irons resistant to corrosive and acid media. Low-alloy gray cast iron, high-silicon iron (ferrosilicon), silicomolybdenum cast iron ("antikhlors") austenitic and high-chromium cast iron are discussed. The chapter also contains an account of methods of preventing corrosion by protective coatings and chemical and thermal treatment.

In the third chapter, the author introduces heat-resistant cast iron. After giving the general outline of metal corrosion, the author describes how the alloying additions in iron affect its resistance to the action of hot gases and high temperature. Next, he discusses the properties of silicon iron, aluminum iron, high-chromium, and other heat-resistant cast iron, and the methods of chemical and thermal treatment of cast iron for the purpose of increasing its heat resistance.

The book is intended for technical personnel concerned with heat resistant cast iron and can be very useful to university students of metallurgy and mechanical engineering.

A. G.

SIGNIFICANCE OF ABBREVIATIONS MOST FREQUENTLY ENCOUNTERED IN SOVIET PERIODICALS

FIAN	Phys. Inst. Acad. Sci. USSR.
GDI	Water Power Inst.
GITI	State Sci.-Tech. Press
GITTL	State Tech. and Theor. Lit. Press
GONTI	State United Sci.-Tech. Press
Gosenergoizdat	State Power Press
Goskhimizdat	State Chem. Press
GOST	All-Union State Standard
GTTI	State Tech. and Theor. Lit. Press
IL	Foreign Lit. Press
ISN (Izd. Sov. Nauk)	Soviet Science Press
Izd. AN SSSR	Acad. Sci. USSR Press
Izd. MGU	Moscow State Univ. Press
LEIIZhT	Leningrad Power Inst. of Railroad Engineering
LET	Leningrad Elec. Engr. School
LETI	Leningrad Electrotechnical Inst.
LETIIZhT	Leningrad Electrical Engineering Research Inst. of Railroad Engr.
Mashgiz	State Sci.-Tech. Press for Machine Construction Lit.
MEP	Ministry of Electrical Industry
MES	Ministry of Electrical Power Plants
MESEP	Ministry of Electrical Power Plants and the Electrical Industry
MGU	Moscow State Univ.
MKhTI	Moscow Inst. Chem. Tech.
MOPI	Moscow Regional Pedagogical Inst.
MSP	Ministry of Industrial Construction
NII ZVUKSZAPIOI	Scientific Research Inst. of Sound Recording
NIKFI	Sci. Inst. of Modern Motion Picture Photography
ONTI	United Sci.-Tech. Press
OTI	Division of Technical Information
OTN	Div. Tech. Sci.
Stroiizdat	Construction Press
TOE	Association of Power Engineers
TsKTI	Central Research Inst. for Boilers and Turbines
TsNIEL	Central Scientific Research Elec. Engr. Lab.
TsNIEL-MES	Central Scientific Research Elec. Engr. Lab.–Ministry of Electric Power Plants
TsVTI	Central Office of Economic Information
UF	Ural Branch
VIESKh	All-Union Inst. of Rural Elec. Power Stations
VNIIM	All-Union Scientific Research Inst. of Meteorology
VNIIZhDT	All-Union Scientific Research Inst. of Railroad Engineering
VTI	All-Union Thermotech. Inst.
VZEI	All-Union Power Correspondence Inst.

Note: Abbreviations not on this list and not explained in the translation have been transliterated, no further information about their significance being available to us. – Publisher.

JOURNAL OF

ANALYTICAL CHEMISTRY

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The top Russian journal in this field, dealing with all phases of analysis, organic and inorganic, including metallurgy, petroleum, spectrochemistry. Sample articles: A simple rational design for the elementary cell of a counter current distribution apparatus; a potentiometric method of determining saponification numbers in solutions of petroleum resins; potassium tetraborate as a primary standard in acidimetry. Translation began with the 1952 volume. Annual subscritpion, 6 issues, approximately 900 pages, $80.00.

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DENDRITIC CRYSTALLIZATION

by **D. D. SARATOVKIN**

2nd Edition,
Revised and Enlarged

Translated from Russian

THIS SIGNIFICANT volume has been extensively revised by the author from the 1953 edition; in particular with *fresh material derived from observations under the stereoscopic microscope.*

The first section deals briefly with some general concepts on crystallization, drawing an important distinction between *genetic* and *structural* types of crystals, including some aspects of the *defect crystal state.* The second section covers at length the illuminating ideas and observations of the 19th-century Russian metallurgist D. K. Chernov, who proposed many of the basic ideas of dendritic crystallization. The third section is an extended survey of current views on dendritic crystallization, in which the ideas of many Soviet and other scientists are briefly summarized and criticized. Section four presents the growth forms of real crystals; all types are reviewed, but only dendritic or closely related forms are selected for subsequent investigation.

Following sections discuss the causes and forms of crystal growth, with *detailed applications* to certain substances that have been extensively studied *(particularly the ammonium halides),* and to eutectics in metal and organic systems; an extensively revised presentation on steel castings which provides a lucid explanation of how the various structures found in real castings can be fitted into the author's theory of dendritic crystallization. Nearly all the concepts developed earlier in the book are utilized in this final section.

The main bulk of the volume contains many *original* and *unpublished* ideas and observations, and is an excellent example of the modern macroscopic approach to the crystalline state by an experienced worker concerned with the infinite variety of real crystals—all of which is enhanced by a *profusion of explanatory line diagrams and sets of stereoscopic photographs.*

CB translations are by bilingual scientists, and include all photographic, diagrammatic and tabular material integral with the text.

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